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AUTOMOTIVE ELECTRONICS

An EFYGROUP Publication

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EDITOR : Ramesh Chopra

EDITORIAL CORRESPONDENCE : Editorial Secretary
Phone: 011-26810601; E-mail: editsec@efy.in
(Technical queries: efylab@efy.in)

SUBSCRIPTIONS & MISSING ISSUES : Phone: 011-26810601 or 02 or 03
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E-mail: powerpioneer@efy.in

JAPAN : Tandem Inc., Ph: 81-3-3541-4166
E-mail: tandem@efy.in

SINGAPORE : Publicitas Singapore Pte Ltd
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FEEDBACK

Article Copied

I would like to bring to your notice that my article 'PC Based Wireless Control for Toy Car' published in EFY September 2010 issue has been copied by Somangshu Bagchi and published in *International Journal of Scientific & Engineering Research* (IJSER) without any notification or prior permission from me. Because of this, the originality of my work cannot be stated at many places.

I wish to register an official complaint against him and also demand the immediate removal of my article from IJSER, Volume 4, Issue 11, November 2013.

Bodhibrata Mukhopadhyay
The author

Radio-Controlled Plane

In 'The Making of a Radio-Controlled Plane' article in April issue, under Battery Pack section, it is mentioned that the battery with 10C rating (800mAh × 10C) gives 8A of continuous current. If the capacity of the battery is 800mA, how can it provide 8A? It can be understood that the battery can provide 800mA for one hour.

Shaikh Adil
Through email

The author T.K. Hareendran replies: C (capacity) rating is the maximum safe continuous discharge rate of a lithium-polymer (LiPo) battery pack. If you see 10C on your LiPo, it means that it can be discharged at ten times that of the pack's capacity.

Capacity refers to the milliampere-hour (mAh) rating of LiPo, which is indicated in the digit followed by mAh (for example, 1000mAh). You may find your LiPo's discharge rate by just multiplying the number from C rating by LiPo's capacity. Here is an example for a LiPo battery with 11.1V, 2000mAh and10C rating.

2000mAh × 10 = 20,000mAh or 20A. This means that, you can safely draw up to 20A continuously from the LiPo pack without causing any damage to your LiPo.

You may also refer to the details given on *www.revolectrix.com/tech_data/lipoCalc/Battery_C_Rating.htm*

From electronicsforu.com: Circuits and Microcontrollers

The 'Alcohol Level Tester' circuit published in EFY June 2014 issue is a good one. Good job, thank you, EFY!

Chaitanya Jadhavar

❏ The 'Weather Logger' project published in EFY January 2014 issue is a good project. It has a very important application in agricultural engineering.

Kareem K.

❏ The 'Speed Controller for Small Cooling Fans' circuit published in August 2014 issue is quite useful. I used a 120-ohm thermistor for a 12V DC fan and the circuit is working fine.

Naveen

❏ I used a 10-kilo-ohm NTC in 'Speed Controller for Small Cooling Fans' circuit and it is working very well.

Sombaran Gupta

❏ Thanks a lot for sharing 'Implementation of Fast Fourier Transform Using C++' DIY software article, published in March 2013 issue.

Swapnil Mishra

'Spot An Error' Award Winners

In 'Intelligent Instrument Cooling Fan Driver' circuit published in May issue, under Parts List, CON2 and CON3 have been wrongly mentioned as 2-pin connectors instead of 3-pin connectors.

Siddharth Kaul

❏ In 'Selecting The Right LED Bulb' article in May issue, EFY efficiency factor for Bajaj should be 85.71 instead of 67.14, according to the formula mentioned in the footnotes.

R. Ruban Ponniah

From Facebook: EFY's Electronics Design Community

Congratulations! You have 800,000 plus likes on your EFY Electronics Design Community page! Keep it up!

Amar Deep Singh

Low-Cost Power Supply

In 'Versatile Low-Cost Power Supply' DIY article published in May issue, the value of capacitor C1 is mentioned as 100nF, 400V in Parts List, whereas in the circuit diagram (Fig. 1), it is given as 100nF, 440V.

Praveen S. Javali
Through email

EFY. Thanks for pointing out the printing mistake! It should be 100nF, 440V, as given in the circuit diagram.

Errata

In 'Buyers' Guide' on LED bulbs (page 109, May 2015 issue), the luminance of Havells LED bulb is 770lm instead of 520lm and the price is ₹ 400 instead of ₹ 600. Therefore EFY lumens factor should be 1.93 and EFY efficiency factor, 110.

Things You Wanted to Know!

Q1. I have two questions. First, how does a processor or controller access data from memory? Second, what is Raspi?

Megha Wali
Through email

A1. ***Accessing data from memory in a microcontroller (MCU).*** Microprocessors and MCUs are different in that, microprocessors do not have inbuilt data memory (RAM) and program memory (ROM), whereas MCUs have both on the chip itself.

In MCUs, operation codes, operands and results are stored in the memory space (ROM and RAM), which is organised into banks segments or pages.

Therefore an arrangement is needed for reaching a location in the data memory space, where the desired operands required by an instruction are stored and where the results after execution of the instruction, if required, are to be stored.

An addressing mode specifies how to calculate the effective memory address of an operand by using the information held in registers and/or constants contained within a machine instruction.

Addressing modes depend on the design of the central processing unit (CPU), memory space and organisation of registers. These differ from MCUs of one brand to another.

There are different ways for addressing a location in the memory space, which are called addressing modes. Some of these are immediate, register direct, absolute, address register indirect, address register relative and relative. In short, data is lodged in data memory space and has address. To get the data, the address is computed by the addressing mechanism.

Let us see how data memory is managed in microcontroller PIC18F4520. Data memory is organised in 16 banks. However, only six banks have been implemented. Each bank has 256 slots and each slot of memory can accommodate one byte or eight bits. So, the addressing mechanism has to compute the address for one slot out of 1536 slots.

Twelve bits will be needed for this; four bits from the bank selecting resistor (BSR) for selecting the bank. Once we are in that bank, further eight bits will be required for selecting the intended slot out of 256 slots in the selected bank. Each of the 12 bits is made up in a different manner depending upon the addressing mode.

In direct addressing mode, all 12 bits are provided by the instruction.

In indirect addressing mode, the instruction provides the pointer and from that pointer, 12 bits are conjured to compute the selection of the bank and the address of the intended location in that bank.

Raspberry Pi. Raspberry Pi, or Raspi, is a computing system that uses a Raspi board, laptop, standard keyboard, mouse, computer monitor or TV, micro USB cable, microSD card with adapter, HDMI cable and network cable for its operations. Programming is done in languages like Python, Wiring Pi, C/ C++ and PHP.

It is capable of doing everything that is expected from a desktop computer, from browsing the Internet and playing high-definition video to making spreadsheets and playing games. The system has the ability to interact with the outside world and has been used in many projects, from music machines to weather stations.

Raspi board has 26 dedicated GPIO pins, including a UART, an I2C bus, SPI bus with two chip selects, I2S audio, 3.3V, 5V and ground. The maximum number of GPIOs can theoretically be indefinitely expanded by making use of the I2C or SPI bus.

Interfacing of the camera module is an interesting application of Raspi. It can take high-definition videos as well as still photographs.

Q2. What is the difference between CDMA and GSM technology? Which, according to you, is better?

R.K. Mishra, GM-Electrical
Universal Cables Ltd, Satna, MP

A2. Code division multiple access (CDMA) and global system for mobiles (GSM) are two major radio systems used in mobile phones. These incorporate multiple-access technologies, multiple phone calls or Internet connections into one radio channel. CDMA is most popular in the USA, whereas GSM is adopted by almost all other countries as the way to communicate via mobile calls.

Differences between the two are:

GSM comes from an industry consortium and CDMA is owned by chipmaker Qualcomm. It is much easier to swap phones on GSM networks using a SIM card. A carrier must accept any GSM-compliant phone, so GSM carriers do not have total control of the phone you are using.

CDMA carriers use network based white lists to verify their subscribers. Therefore you can only switch phones with your carrier's permission, and a carrier does not have to accept any particular phone onto its network.

3G CDMA networks cannot make voice calls and transmit data at the same time, which is not the case with 3G GSM networks.

GSM is based on time-division system. Voice is transformed into digital data, which is given a channel and a time slot. The receiver listens only to the assigned time slot and pieces the call back together.

CDMA is a code-division system. Every call's data is encoded with a unique key and calls are all transmitted at once. Each receiver has the unique key to divide the combined signal into its individual calls.

In short, GSM or CDMA ultimately provide the same service and the quality of a network depends on the carrier.

Answers compiled by EFY joint director (training), Col. N.C. Pande (Retd). Letters and questions for publication may be addressed to Editor, Electronics For You, D-87/1, Okhla Industrial Area, Phase 1, New Delhi 110020 (e-mail: editsec@efy.in) and should include name and address of the sender

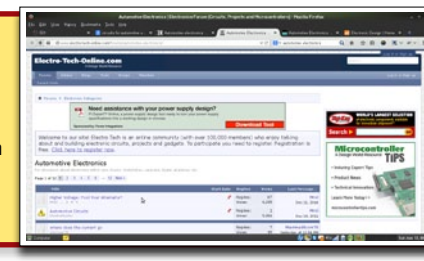
Automotive Electronics

With the growth of technology, electronics has become a major game changer in the automotive industry. Here are a few websites that could help you understand more

NIRAJ SAHAY

electro-tech-online.com

Electro Tech is an online community with over 100,000 members, who enjoy talking about and building electronics circuits, projects and gadgets. The forum has a dedicated section for discussion on automotive electronics. In order to participate, you need to register, and registration is free.



www.electro-tech-online.com/forums/automotive-electronics

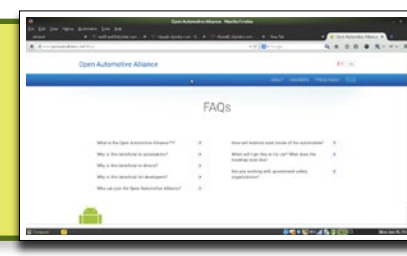
cvel.clemson.edu

Clemson Vehicular Electronics Laboratory (CVEL) conducts targeted research related to automotive and aerospace vehicle electronics including electronics components, circuits, sensors, communication and power distribution with emphasis on systems integration, electromagnetic compatibility and modelling. The website is a rich resource for learning these topics. It has details of electronics systems for automobiles.

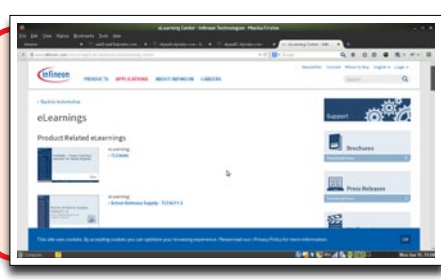
www.cvel.clemson.edu/auto/index.html

openautoalliance.net

Open Automotive Alliance (OAA) is a group of technology and automotive companies that have come together to bring the best of Android into the automobile world in a safe seamless way. Members of OAA share a vision for the connected car and are committed to collaborating around a common platform to make this vision a reality. The website is a place to know who, why and what about OAA.



www.openautoalliance.net



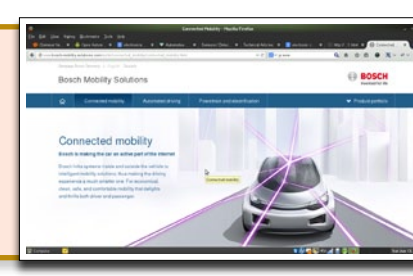
infineon.com

Infineon is the world's second-largest chip supplier to the automotive industry. They manufacture innovative semiconductor products covering the complete control loop, contributing to a more sustainable mobility in terms of reduced fuel consumption/emission, improved safety and affordability. The website works as a learning centre for available electronics products for the automotive industry. It has e-learning and Videos sections that can be of interest to people interested in automotive electronics.

www.infineon.com/cms/en/product/applications/automotive/download-eLearning.html

bosch-mobility-solutions.com

Bosch Group is a global supplier of technology and services. The group's strategic objective is to create solutions for a connected life. Bosch improves the quality of life worldwide with products and services that are innovative and spark enthusiasm. The website is a good place to learn more about the latest in automobile and electronics technology.

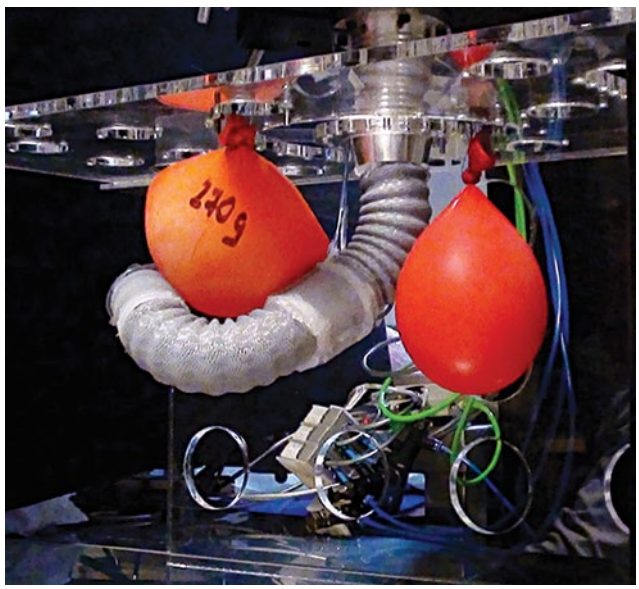


www.bosch-mobility-solutions.com/en/de/index.html

TECHNOLOGY AT YOUR SERVICE

Robotic arm that can perform surgery

A robotic arm, inspired by an octopus' tentacles, is set to make it easier for surgeons to access hard-to-reach parts of a body. The device uses a series of inflatable chambers to imitate how an octopus moves its limbs in any direction. The robot's mechanical arm



Octopus-inspired robotic arm (Credit: Tommaso Ranzani et al)

can also mimic the way the animal can change the stiffness of different sections of its tentacles, enabling better interaction with objects. A section of the robotic arm is built to handle soft organs without damaging these, while another section operates on the patient.

This technique could minimise the number of instruments needed for surgical procedures, which means that doctors would need to make fewer entry incisions on patients, lessening the chance of postoperative complications.

This robotic arm, which is made of soft material, is capable of carrying out multiple tasks during an operation, unlike other flexible surgical robotics.

Robots can now think like humans

Based on new algorithms developed by researchers from University of California, Berkeley, the USA, robots can now learn from their mistakes just like humans do. Researchers were able to level up artificial intelligence (AI) by making the robots learn motor tasks using trial and error.

The robot named BRETT stands for Berkeley Robot of the Elimination of Tedious Tasks. Using the technique developed by reaserchers, the robot learns to recognise patterns and categorise data that it receives using deep learning programs that can create neural nets in which overlapping raw sensory data (sound wave or image pixels) can be processed by layers of artificial neurons.

Since the robot does not have any pre-programmed knowledge on its environment, it can successfully assemble basic objects after several attempts.

BRETT's first task that was to assemble a toy airplane wheel took 12 minutes before completion. Eventually, it applied the same algorithm that it learned from the toy airplane to its second task on Lego bricks and finished the task almost right away.

Technology to put electronics into the brain

Latest technologies have allowed a paralysed man to drink from a cup unaided using a robotic arm, the deaf to hear and the blind to see, using brain implants that are electrical devices inserted into or attached to the brain.

At present, implants require invasive surgery and are often made of metals that may cause scarring. Brain implant technology is hampered by how long implants can stay in the brain without losing functionality.

Now, a tiny new brain implant makes a breakthrough in this area. It can be injected directly into the brain using a syringe, minimising damage to brain tissue. The flexible mesh mimics the interconnecting structure of the neural network and the softness of brain tissue. It is made of materials that the immune system is less likely to reject, resulting in less scarring in the brain.

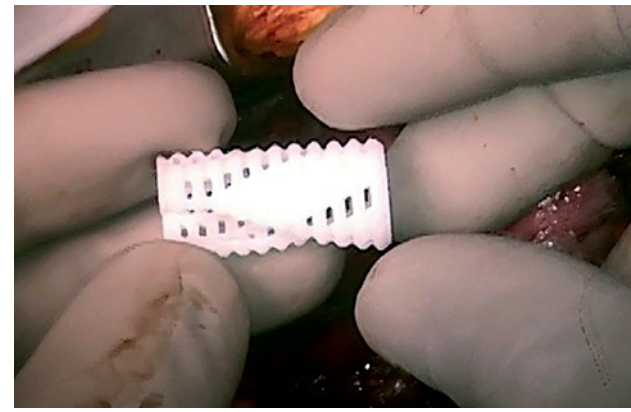
The implant contains very fine metal lines of circuitry embedded on it, with electrodes and sensors mounted at intersections of wires. After being injected into the brain, it unfolds to about 80 per cent of its original shape without losing function. External wires of the mesh can then be plugged to a computer to monitor and stimulate individual neurons.

4D-printed implant saves lives

Recently, a 4D biomaterial, a medical implant designed to change shape over time allowed three children to keep breathing, in effect, saving their lives. The implants were made using a 3D printer, which can create items from a wide variety of materials such as plastic, ceramic, glass, metal and even living cells.

Scientists have now begun developing techniques to try out 4D printing, which involves 3D printing items that are designed to shape-shift after being printed.

The three infant boys who were implanted with the new device were suffering from tracheobronchomalacia, a disease that causes the windpipe to regularly collapse, preventing normal breathing. Researchers used CT scans of the boys to develop 3D-printed airway splints whose



3D-printed tracheobronchial splint used in one of the baby boys [Image courtesy: Morrison et al., Science Translational Medicine (2015)]

length, diameter, thickness and other factors were customised for each baby.

The splints, made of polycaprolactone that dissolves in the body over time, were implanted into the babies and sewn around their windpipes; devices kept surrounding tissue from pushing in and sealing the airways shut. These hollow and porous splints were designed to spread open as the children grew.

Hyperlens that helps view tiny objects

According to scientists, a slinky hyperlens can help us see tiny objects that elude even the most powerful optical systems. The metamaterial hyperlens may someday even help detect some of the most lethal forms of cancer. It is also expected to lead to advancements in nano-electronic manufacturing and boost a scientist's ability to examine single molecules.

Conventional optical systems, such as microscopes and cameras, are limited by diffraction, a phenomena in which light bends as it passes around an edge or through a slit.

Metamaterial hyperlenses overcome the diffraction limit by transforming decaying evanescent waves into propagating waves. Once converted, the former decaying waves, which were commonly lost in conventional imaging, can be collected and transmitted using standard optical components.

Lift your house in case of an earthquake

The future vision for Greg Henderson of Arx Pax, makers of Hendo Hoverboard, is deploying the technology Hendo Hoverboard uses on a large-scale to protect houses during a massive earthquake.

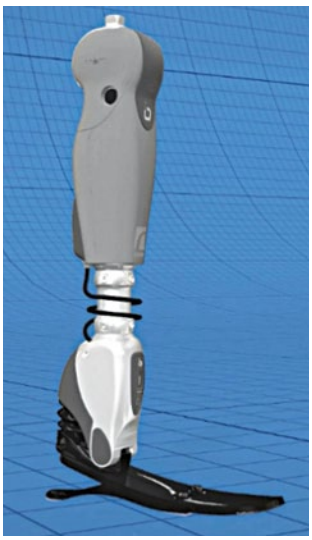
Arx Pax has in place systems that employ water or gas to lift homes. It, however, aims to eliminate the structural movement entirely and use magnets instead. Their goal is to have the building's landing gear react and activate the hover engines as soon as an earthquake strikes.

In order to lift a three-story home for about 90 seconds, which is the length of an average earthquake, the power required can be supplied using five car batteries.

Arx Pax would require installation of the hover engines and an earthquake-proof base. Computers would automatically turn on the engines as soon as these sense an earthquake. These will also have ShakingAlert software system that senses earthquakes, integrated in the system, which has successfully detected earthquakes in the past.

Bionic legs that are thought-controlled

Researchers in Iceland have developed bionic legs that can be controlled by a person's thoughts alone. It involves surgically implanting myoelectric sensors (IMES) into a person's residual muscle tissue to measure and interpret signals travelling between the brain and its nerve-endings. The implanted sensors send wireless signals to the artificial limb's built-in computer, enabling subconscious, real-time control and faster, more natural responses and movements.



Bionic leg that can be controlled by thoughts (Image courtesy: Ossur)

This new mind-controlled technology developed by Ossur for lower-limb prosthetics is designed to be compatible with its line of bionic feet, knees and legs. A coiled-wire receiver inside the prosthesis' cup picks up impulses and transmits these wirelessly to the robotic limb.

A computer made out of water droplets

An assistant professor of bioengineering at Stanford University, the USA, Prof. Manu Prakash has created a water based computer. He, along with his two students, has devised a system with the help of tiny water droplets that could work as a computer clock.

For this, water droplets are trapped in a magnetic field. When applied to a flipped magnetic field, these form a precise motion in a fixed direction.

According to the team, the system can be made smaller by controlling millions of droplets with the help of the magnetic field, so that it can perform a higher number of operations on a single chip.

According to Prakash, this computer founds its application in biology and chemistry by converting the computer into a high-throughput laboratory.

Power gadgets from six metres away

A team of engineers from University of Washington, Seattle, the USA, has presented a research paper titled 'Powering the Next Billion Devices with Wi-Fi' that

discusses how a Wi-Fi router can be used to provide far-field wireless power for gadgets. In their first prototype, for the first time in the world, they have demonstrated how Wi-Fi chipsets can power camera sensors or li-ion coin-cell batteries from more than 6m (20-feet) away. Wi-Fi receivers had so far been used to capture information from Wi-Fi radio broadcasts. The research team has sought a way to harvest energy from these broadcasts.

The engineers connected an antenna to a temperature sensor and put it near a Wi-Fi router so that voltages in the device could be measured to determine the time for which the device could operate on a remote power source. To make things work, they programmed these devices for broadcasting continuous power to an energy-harvesting sensor. The results showed that a temperature sensor could operate at a distance of up to six metres.

Pocket-size drone that can fold up

Researchers have designed a small, foldable drone, inspired by origami, which can unfold itself automatically and take flight within a fraction of a second. A large number of these quadcopters, the size of an outstretched palm, could be released over a disaster zone to take photographs and make contact with survivors.

When the device is not in use, the arms, which are made of fibre glass and light, yet rigid polyester, fold up into a trapezoid. When switched on, force of the propellers causes the arms to unfold horizontally. Then, magnets keep the arms locked into position.

For the drone to remain stable during flight, two propellers (diagonally across from each other) spin in opposite directions from the other two. Propellers all spin in the same direction at first while the drone unfolds, but a sensor detects when the arms have locked into position, and within 50 milliseconds, direction of two of the rotors is reversed, and the drone is ready to take flight.

World's first electronic multi-state memory cell

Researchers at RMIT University's MicroNano Research Facility (MNRF), Australia, have built the world's first electronic multi-state memory cell that can mirror a brain's ability to simultaneously process and store multiple strands of information.

This brings them closer to imitating key electronic aspects of the human brain, which is an important step towards creating a bionic brain. This could help unlock successful treatments for common neurological conditions such as Alzheimer's and Parkinson's.

Project leader Dr Sharath Sriram, co-leader of RMIT Functional Materials and Microsystems Research Group, has said that the ground-breaking development imitates the way the brain uses long-term memory.

The research builds on RMIT's previous discovery where ultra-fast nano-scale memories were developed using a functional oxide material in the form of an ultra-thin film, which is 10,000 times thinner than a human hair.

Google, Levi Strauss to launch smartclothes

Google is all set to tieup with popular jean maker Levi Strauss to launch smartclothes using particular woven fabric with touchscreen-control capabilities. Named Project Jacquard, the plan would be implemented by a small team at Google called Advanced Technology and Projects (ATAP).

The project is named Jacquard after a Frenchman who invented a type of loom. While the clothes are expected to be stretchable and washable like normal fabric, these would also be able to connect with devices. Special threads would be woven into a wide array of fabrics. However, conductivity will be limited to desired parts of the fabric or spread across entire cloth.

Google has said that, with the use of standard, industrial looms, touch and gesture interactivity could be woven to any textile. Hence, anything involving fabric is likely to have computer touchpad-style control capabilities woven into it.

ATAP also said that the conductive yarn would be connected to minute circuits, no bigger than jacket buttons and small electronics that can use algorithms to recognise touch or swipes.

Daimler, Qualcomm to develop in-car tech

Car maker Daimler and Qualcomm Inc. have partnered to develop wireless recharging of mobile phones in cars as well as recharging of electric cars without cables.

The two companies are assessing the application of wireless technology to charge their electric vehicles (EVs) and plug-in hybrid EVs without having to plug these in. They are also exploring technologies that will enable customers to wirelessly charge devices such as mobile phones while driving their cars, as well as ways to enhance in-car experience through high-speed 3G/4G connectivity.

Dyson CSYS LEDs to stay bright for 37 years

LEDs are meant to last for a long time, but if not properly heat shielded, these tend to lose their brightness and colour. Jake Dyson of Jake Dyson Light has designed CSYS LEDs that will stay bright for 37 years.

Conventional applications fail to protect LEDs from heat and are often subjected to temperatures up to 130°C. The heat has a damaging effect on the phosphorous coating of the bulb, which results in degradation in brightness and colour over time.

CSYS task lights have been engineered to use heat pipe technology that takes away the heat from the LEDs and keeps them cool at around 55°C. The lower temperature allows the lights to stay bright for 37 years.

Check efytimes.com for more news, daily

Autonomic Computing Without Human Intervention

Deepak Halan is currently associate professor at School of Management Sciences, Apeejay Stya University

In August 2013, computer scientists from Japan and Germany managed to simulate one per cent of human brain activity for a single second. To achieve this apparently simple task, they had to deploy as many as 82,000 processors. These processors were part of Japan's K computer, the fourth most powerful supercomputer on Earth. The computer scientists simulated 1.73 billion virtual nerve cells and 10.4 trillion synapses, each of which contained 24 bytes of memory. The entire simulation consumed 40 minutes of real, biological time to produce one virtual second.

This shows the complexity and prowess of the human brain. It is extremely difficult to recreate human brain performance using computers, since the brain consists of a mindboggling 200 billion neurons that are interlinked by trillions of connections called synapses. As the tiny electrical impulses shoot across each neuron, these have to travel through these synapses, each of which contains approximately a thousand different switches that direct an electrical impulse.

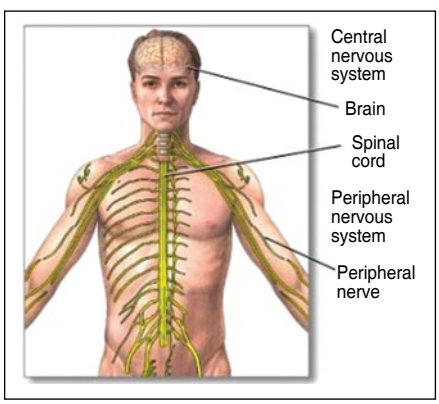


Fig. 1: The autonomic nervous system has two divisions: sympathetic and para-sympathetic (Image courtesy: blogs.scientificamerican.com)

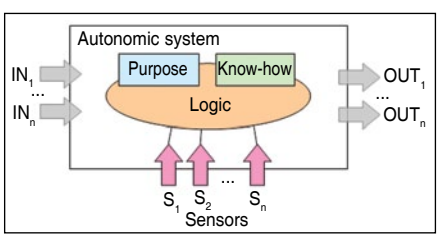


Fig. 2: A fundamental building block of an autonomic system is its sensing capability (Image courtesy: http://en.wikipedia.org)

Human beings have managed to automate increasingly complex tasks. However, perhaps, we have only seen the tip of the iceberg. While a large number of enterprises use information technology (IT) by way of thousands of diverse gadgets and devices, in majority of cases, it is human beings who operate these devices, such as smartphones, laptops and scanners. The intricacy of these systems and the way these link and operate together is leading to the scarcity of skilled IT manpower to manage all systems.

The smartphone has become an integral part of our life today as it often remains connected with our desktop, laptop and tablet. This concurrent burst of data and information and, further, its integration into everyday life is leading to new requirements in terms of how employees manage and maintain IT systems.

As we know, demand is currently exceeding supply of expertise capable of managing multi-faceted and sophisticated computer systems. Moreover, this issue is only growing with the passage of time and our increasing reliance on IT.

The answer to this problem is autonomic computing, that is, computing operations that can run without the need for human intervention.

The concept of autonomic computing is quite similar to the way the autonomic nervous system (ANS) (Fig. 1) regulates and protects the human body. The ANS in our body is part of a control system that manages our internal organs and their functions such as heart rate, digestion, respiratory rate and pupillary dilation, among others, mostly below the level of our consciousness. The autonomy controls and sends indirect messages to organs at a sub-conscious level via motor neurons.

In a similar manner, autonomous IT systems are based on intelligent components and objects that can self-govern in rapidly varying and diverse environments. Autonomous computing is the study of theory and infrastructures that can be used to build autonomous systems.

In order to develop autonomous systems, we need to conduct interdisciplinary research across subjects such as artificial intelligence (AI), distributed systems, parallel processing, software engineering and user interface (UI).

Even though AI is a very important aspect for autonomic computing to work, we do not really need to simulate conscious human thoughts as such. The whole emphasis, today, is on developing computers that can be operated intuitively with minimum human involvement. This demands a system that can crunch data in a platform-agnostic manner. And much like the human body, this system is expected to carry out its functions and adapt to its user's requirements without the need of the user to go into minute details of its functioning.

Fig. 3: Arnold Schwarzenegger, in the Terminator franchise, which first came out in the 1980s, has an expert self-healing computer system at its core (Image courtesy: www.hollywood.com/news/movies)

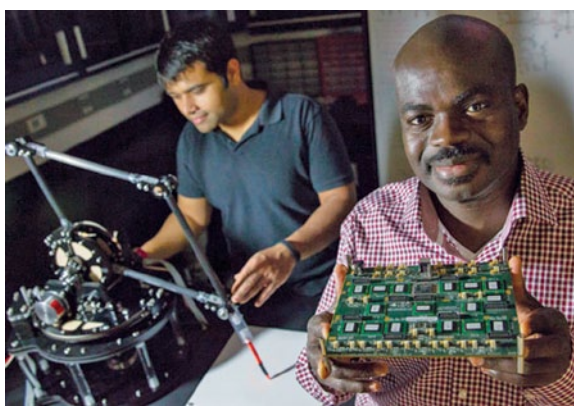


Fig. 4: A biologically-inspired processor attached to a robotic arm in a laboratory at Stanford University, the USA (Image courtesy: www.nytimes.com)

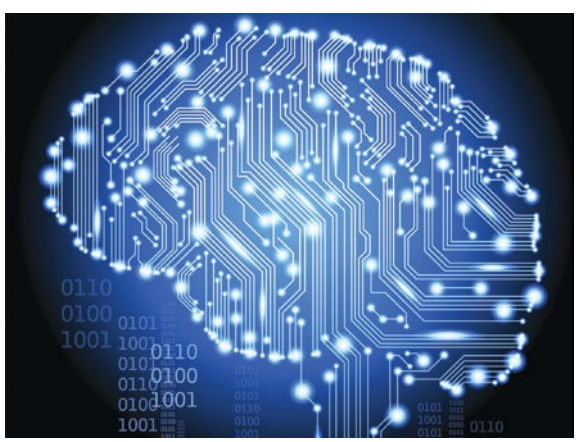


Fig. 5: A computer-simulated protein-folding image (Image courtesy: www.isgtw.org/feature/)

Self-management in autonomic computing

The very core of autonomic computing systems is self-management, which aims to provide freedom from tasks of system operation and maintenance, and to make available a device that works at peak performance 24 hours a day. The day-to-day working is maintained in a dynamic environment of rapidly and constantly-changing workloads, user requirements and virus attacks, and so on.

The system can also repeatedly keep an eye on its own functioning, for example, let us say, a particular component needs to be checked for upgradation. If an error is detected, the system automatically goes back to the last error-free version, while its problem-determination algorithms work towards identifying and removing the source of the error.

The IBM autonomic computing team has broken the self-management aspect further into four dimensions, namely, self healing, self optimising, self protecting and self controlling.

Self controlling. An autonomic computing system should be able to configure and reconfigure itself under diverse and volatile conditions. The system configuration, or set-up, and the dynamic adjustments to the configuration, in order to manage dynamic environments, must occur automatically.

Self optimising. Interestingly, an autonomic computing system is never satisfied with the status quo and is forever looking for ways to optimise its working. It monitors its constituent elements and makes adjustments to the workflow to achieve predetermined system goals.

Self healing. An autonomic computing system must act like the human body in terms of healing itself. It should be able to bounce back from everyday, as well as unforeseen, problems that might cause some of its parts to fail.

It should be able to find out existing or potential problems and then seek out an alternative way of using resources or reconfiguring the system to keep functioning efficiently.

Self protecting. The virtual world faces as many threats as those faced by a physical world. Hence, an autonomic computing system should be very well-versed in the art of self protection. It should be capable of detecting, identifying and guarding itself against different types of attacks to preserve the overall system security and integrity.

The self-learning aspect

Like human beings, computers are slowly evolving into devices that learn from their own mistakes. The concept is based on the human nervous system, particularly the way our neurons act in response to stimuli and link up with other neurons to construe information. This phenomenon enables computers to digest new information while executing a job and then make changes based on varying inputs.

In the near future, a new generation of AI systems is expected to perform tasks such as speaking and listening, among others, which humans can easily do.

There is a gradual shift from engineering computing systems to one that has several characteristics of

Fig. 6: Blue Gene, a supercomputer based on mobile architecture (Image courtesy: http://en.wikipedia.org)

biological computing systems since the engineering type is restricted to doing only what these have been programmed for. Biological computing style could be made possible in a few years, such as robots that easily drive and walk in the real world. However, a computer that is capable of thinking may probably take a few decades.

Some application areas

Autonomic computing is expected to simplify the management of computing systems and open doors to applications such as seamless e-sourcing, grid computing and dynamic e-business.

E-sourcing is the ability to bring in IT as a utility, at the time it is required and in the needed quantity to complete the work.

Some other autonomic computing applications areas are memory error correction, server-load balancing, process allocation, monitoring power supply, automatic updating of software and drivers, automated system backup and recovery, and prefailure warning.

Autonomic cloud computing is related to empowering cloud infrastructures and platforms so that these can take their own decisions to incessantly achieve their assigned jobs. Cloud systems are required to consistently deliver their functionalities and facilities to users without any form of human intervention, interpretation and instruction.

Grid computing is one area where autonomic computing equipped with self-managing capabilities can add a lot of value, and there are many related projects in process.

University of Pennsylvania, the USA, is making a potent grid that targets to bring advanced methods of breast cancer diagnosis and screening to patients at a low cost. The grid is a utility-like service delivered over the Internet, enabling hundreds of hospitals to store mammograms in digital form. Analytical tools that aid doctors to diagnose individual cases and discover cancer clusters in the population are also available.

Then, there is North Carolina Biometrics Grid, which is available to thousands of researchers and educators to facilitate boosting the speed of genomic research that is likely to result in new medicines to fight diseases and grow more nutritious foods to satisfy global hunger.

Better access to higher computing power via grid computing integrated with the implementation of open standards will allow researchers to work together more easily on complex issues, which should benefit all mankind.

Weather forecasting and protein folding, where intricate medical calculations are needed, are application areas that need computers to work 24/7, continuously for a couple of years.

Progressively autonomic computers will provide tools to analyse these complex problems. Systems with mobile architecture, such as Blue Gene (Fig. 6), will allow the study of phenomena happening in split seconds at an atomic scale.

Autonomic computing will be able

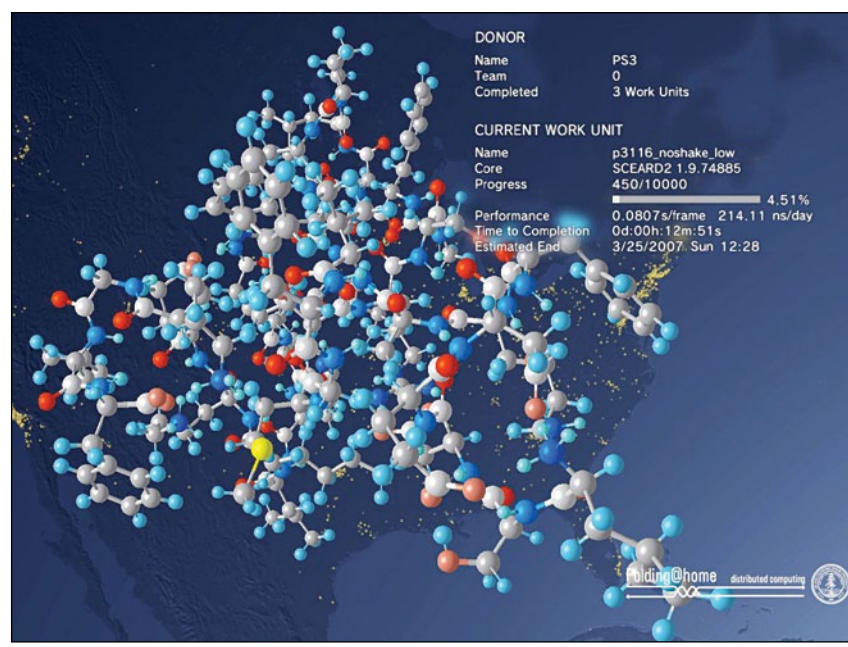


Fig. 7: Engineers are now beginning to understand that intuitive computing that calls for mimicking some or all aspects of the human brain (Image courtesy: http://programming4.us/enterprise/24086.aspx)

to better harness existing processing power to run complex mathematics for functions such as weather simulations and other scenarios that require public systems and infrastructure.

Human intervention will keep reducing in most tasks linked with systems management in the years to come. In fact, it will seem as pointless as asking a telephone operator for facilitating an STD call looks today.

Autonomic computing will make computers that serve you in some way, just like your airline, telecom operator, bank, and hotel, a reality. We are unlikely to hear responses such as "please try again later as our systems are slow or down."

At the same time, autonomic features will begin to make way into client-level devices. This will allow the personal computer to finish several jobs, which till now required some level of human intervention, on its own.

Future scope

Perhaps, we have only discovered the tip of the autonomic computing iceberg and are oblivious of the many technical roadblocks that will come in the way. Autonomic computing is at an embryonic stage and there are several critical challenges to be overcome.

Some questions that need to be answered are:

How will we design our systems to define and redefine themselves in dynamic environments? (A system should know its periphery limits before it transacts with other systems.)

How will we build reliable interfaces and points-of-control while permitting a heterogeneous environment? (Multi-platforms create a multi-faceted situation for system administrators.)

How will we develop human interfaces that eliminate complexity and enable users to interact naturally with IT systems? (The final result needs to be crystal clear to the user.)

How can we bring together a group of autonomic components into a federated system? (Just creating autonomic components is insufficient.)

How can we design and support open standards that will perform? (Standardisation is critical as the era of proprietary solutions has ended.)

How can we produce adaptive algorithms to take past system knowledge and use those insights to perk up the rules? (Creative and new methods will be required to equip our systems to tackle the dynamic nature of environments and transactions.)

Research related to development of autonomic systems is indeed complex and challenging. However, future computer systems will need higher levels of automation if these are anticipated to manage the rapidly-increasing amounts of data, the ever-growing network and the rising force of processing power. While there are computers with various levels of automation, fully-autonomic systems remain a dream for the future. ●

Age of The Drivables

Janani Gopalakrishnan Vikram is a technically-qualified freelance writer, editor and hands-on mom based in Chennai

Road safety slogans like 'Alert Today; Alive Tomorrow' might become redundant in the future with the kind of safety, information, communication, entertainment and comfort features that are being built into today's cars.

We add to that fascination some lesser-known but equally exciting research projects, which are bound to augment the capabilities of tomorrow's smartcars.

Born-in-Bengaluru tech could help the visually impaired to drive

Since late last year, Tech Mahindra has incubated special goggles designed by its employee Kunal Bhat. Bhat, who accidentally banged his head on a wall in a dimly-lit staircase, decided to set about finding a tool that could help the visually impaired to visualise obstacles in their way much before these are sensed by their canes.

Working on this idea, he developed smartgoggles, which together with a smartphone, helps users to sense things on their path and form a 3D mental image of their surroundings.

How does it work? The smartphone camera captures the user's environment, identifies objects of collision and calculates their position and distance using special algorithms. This information is wirelessly transmitted to the goggles. The smartglasses fitted in the goggles convey this information to the wearer through haptic feedback. It uses mild vibrations from relevant directions to help him or her feel the world around, for a radius of 1.5m (5-feet). A fluent flow of vibrations helps the user form a 3D mental image of the surroundings.

The current prototype is being tested by Tech Mahindra at Bengaluru with the help of two social organisations. Future versions are expected to have more capabilities like audio feedback, context-sensitive analysis, location and direction feedback, cloud based analysis, collective intelligence and inter-device communication.

Why this is featuring right at the beginning of a story on smartcars is because Tech Mahindra believes that this technology can be adapted to applications like autonomous cars and plans to upgrade the application to driverless cars in the future.

The mystic appeal of quantum tech to navigate into the future

The Global Navigation Satellite System (GNSS), which is being relied upon today for almost all forms of navigation, including that of smart and autonomous cars, is not without its share of flaws. For one, it depends on signals sent to and from satellites launched into outer space, which makes it a costly affair to maintain the constellation and improve capacity.

Secondly, there are occasional reports from the US government agencies about GNSS-related security risks and their vulnerability to attack. Limitations of GNSSes under water are also known, making these ineffective for use with submarines.

In order to overcome all this, scientists at the UK

A man in an autonomous driving test vehicle

Defence Science and Technology Laboratory (DSTL) have developed a quantum compass that can achieve similar functions using the subatomic changes in Earth's magnetic field.

The technology used is totally unlike anything you have heard of before. Special lasers are used to cool atoms to temperatures much colder than outer space. At such low temperatures, the slow-moving, low-energy atoms become extremely sensitive to changes in Earth's magnetic and gravitational field. According to the team's press report, "If trapped on a small device, their tiny fluctuations can then be tracked from great distances away and their locations pinpointed with a huge degree of accuracy."

What makes this technology appealing to smartphone companies and autonomous carmakers is that, it has a very high degree of security. Unlike a GNSS, no outside interference can disrupt it. Bob Cockshott of National Physics Laboratory, the UK, commented in a media report that, "There is nothing in physics that could be used—given the knowledge we have now—to disrupt one of these devices."

It is expected that usable quantum compasses will hit the market by 2019. These will be so small that these could easily be fitted into small chips, making these easy to use, not just in vehicle navigation but also in a variety of devices including smartphones.

Game to print your car

Talking of smartcars, here is a smart way to make your car! At the annual motor show in Detroit this year, Local Motors was seen 3D printing a car. The American motor vehicle company attaches no fixed location or mammoth factory to their brand. They call themselves a free online and physical workspace where creativity, collaboration and design drive vehicle innovations. They claim that the future will be characterised by microfactories, where small work areas will become car factories. Perhaps one day, you could use your garage for more than parking your car; you could be making cars in it!

What makes us think so? Strati, the co-created car that was being printed at the motor show, is a two-seater that can go up to 40km per hour and is meant for local usage. It takes about 44 hours to digitally print the car as of now, but the company expects that by the end of the year, they will be able to do it in 24 hours, gradually taking it down to 10 hours to 12 hours. The frame and panels of the car are printed using carbon-fibre-infused plastic. It comprises 200+ layers and weighs approximately 800kg. And all this is done using a machine that can comfortably sit in your garage.

The company believes that the car would last five to six years if parked outside, exposed to the weather, and much longer if parked safely in a garage. It is fully-recyclable. So, when it is time for a change, you can salvage the recyclable material and sell it to the company. Local Motors has already opened bookings for the car, which is expected to be available this year.

Quick to follow was Chinese company Sanya Si Hai 3D Technology Ltd, that also 3D printed a 500kg car in March this year. Dubbed Shuya and later called Tyrant Gold, this car was printed with a composite material in around five days. Although the car took much longer to print, its electric motor is capable of achieving the 40km per hour speed of Strati.

Robot city to test driverless cars

Our stories this month might seem to be aimed at convincing you of the possibility of seeing driverless cars on our roads a decade down the line, but we can surely not convince you enough to let driverless cars be tested on the roads in the near future. Just recently, an investigation by Associated Press revealed that four of the 48 self-driving cars on California's roads have been involved in four accidents since September 2014.

Foreseeing this danger, University of Michigan has set up M City, a US$ 6.5 million, 23-acre, driverless mini metropolis. The city, set to open in July, has 40 building facades, angled intersections, a traffic circle, a bridge, a tunnel, gravel roads, obstructed views and even a four-lane highway with entrance and exit ramps. It tries to emulate real-life chaos as well. It is possible to reroute traffic, change signal durations and alter road layouts and building facades.

Bad weather, traffic jams, people jaywalking, moms pushing strollers and senior citizens crossing the roads are all a common sight at M City. Fortunately, these are just mechatronic pedestrians testing the sensors and automatic brakes of autonomous vehicles. Self-driving cars being tested there can sense each other, the environment and so on, to ease congestion and improve road safety.

Car pooling in driverless cars, inter-car communications to optimise routes and pick-ups, etc can all be tested to help taxi operators improve the efficiency of operations. It is no wonder industry majors from Ford and Toyota to General Motors are eagerly awaiting the facility's inauguration.

Taking care of every small detail

No road is 100 per cent safe to drive on. There are invariably some blind spots, which sometimes lead to accidents. In a quest to avoid this, Jaguar Land Rover is developing a smartwindscreen that uses two technologies, which they call transparent pillars and follow-me ghost cars.

Based on the understanding that the pillars supporting the roof of the car obstruct the driver's view, the company is developing transparent pillars. This would be achieved by embedding screens on the insides of the pillars to relay a live video feed from cameras covering various blind spots around the car. Their futuristic

Did you see a driver in that car

Here are some of the autonomous cars expected to hit the roads in the very near future:

- Tesla Motors' self-steering Model S sedan
- General Motors' hands-free highway-driving Cadillac
- Mercedes-Benz hands-free system

Apart from this, numerous car makers ranging from Honda and Hyundai to Toyota are gradually introducing some of their autonomous steer-and-stop features in cars in a phased manner. Google's autonomous cars are also seen driving around Silicon Valley, California, and it is believed that these will be commercially available within five years.

heads-up display technology will add to this unobstructed view, by providing information to keep the driver's full attention on the road. For example, the movement of others on the road could be highlighted with an onscreen halo moving across the car's virtual windscreen.

Further to these navigation aids, a ghost car could be projected in front of the car for the driver to follow, in case of difficulty in navigating through busy urban roads.

These concepts are part of a suite of connected technologies being developed by Jaguar Land Rover to improve road safety. According to the company's press reports, the full potential of this windscreen would be delivered by connecting it to the cloud.

More power to electric vehicles

While smartness is one of the dominant quests in the automotive industry, the other is the quest for efficient electric vehicles that could reduce environmental hazards of the ever-increasing number of vehicles plying on roads today. Understandably, several research initiatives are targeted at this.

Tiny yet powerful nanopores. In a US Department of Energy-funded research at University of Maryland, the team has invented a tiny structure that includes all components of a battery, representing what they claim to be the ultimate miniaturisation of energy-storage components.

Called nanopore, this structure features a tiny hole in a ceramic sheet that holds the electrolyte to carry the electrical charge between the nanotube electrodes at either end. The battery can be fully charged in 12 minutes and can be recharged thousands of times.

Millions of these nanopores can be combined into one larger battery, the size of a postage stamp. Since all nanopores are sized uniformly, it is possible to cram innumerable units into a single battery. Such thin, small and efficient batteries are expected to revolutionise electric vehicles (EVs) as it is possible to store lots of energy within a small footprint and in a very light package, too.

Pop goes the crystal, catching all the light. Recently, a team of scientists led by Prof. Jagadese J. Vittal at National University of Singapore (NUS) discovered a chemical reaction that can make microscopic crystals leap distances of hundred times their own size when exposed to ultraviolet (UV) light. This distance is comparable to a human jumping several metres.

In simple terms, this is the conversion of light energy into mechanical motion. But, what makes it so exciting is that, it is the first time scientists have found such a photosalient effect driven by a photochemical reaction in solids, which makes it amenable to several applications. For instance, it could result in a fresh new approach for directly converting solar power into mechanical motion, such as the movement of light-driven actuators and mechanical devices.

Another positive note in this research is that, this phenomenon comes into effect even when crystals are irradiated with weak UV light. Perhaps one day, this would lead to EVs driven directly by the sun with not many middle men in between.

Nano gives superpower to supercars. Another nanotech breakthrough in this space comes from Queensland University of Technology (QUS). Here, researchers have developed lightweight supercapacitors that can be combined with regular batteries to give a power boost to electric cars.

An electrolyte is sandwiched between two all-carbon electrodes to make a thin and strong film with high power density. These film-like supercapacitors can be easily embedded into a car's body panels, roof, doors and so on. Being super-efficient and capable of covering a large area, these can store enough energy to charge a car's battery in just a few minutes.

According to a press report, "Supercapacitors offer a high power output in a short time, meaning, a faster acceleration rate of the car and a charging time of just a few minutes, compared to several hours for a standard electric car battery."

While currently supercapacitors are used along with li-ion batteries, in the future, they hope that supercapacitors will be capable of storing more energy than li-ion batteries and releasing this energy up to ten times faster, so that a car can be entirely powered by the supercapacitors in its panels. Expected to become a reality in a decade or so, such a car can run up to 500km on a single full charge.

Indeed, so much is happening in the automotive industry to improve driving comfort, safety and energy-efficiency that, it is mind-baffling.

In an amazing opinion piece in *The Guardian*, Tom Chatfield writes, "For those of us who do drive, the moment we get behind the wheel, we are embarking upon the most skilled, perilous and logistically fraught act of our daily lives. We are sitting inside the most expensive hunk of consumer technology we own." No wonder, he believes that smartcars will become much more popular that wearables. Yes, we are at the threshold of the age of the drivables! ●

Float Like a Cadillac, Sting Like a Beemer

Dilin Anand is a senior assistant editor at EFY

The car woke from its nap and drove over to where they were waiting. As they approached, a female's voice rang out from the car to say, "Please go ahead," letting them know that it was safe to pass in front of the car. Using sensors, the car had detected that there were others nearby and automatically started slowly opening the car's four bay doors.

Sounds futuristic? Of course, it does. But what you just read was what had been experienced by the very fortunate Verne Kopytoff of *Fortune.com*, as he took a ride in Mercedes-Benz F 105 autonomous car, earlier this year.

A world with vehicles as intelligent as those in the Disney movie, Cars, would truly be a wonderful place to live in, but there is quite some distance to go. As kids on a family trip would say, "Are we there yet?"

Your car is your new gadget

The colossal power of the Internet is now within your car's grasp.

Android Auto. Android Auto is a telematics standard that allows you to connect your car to an Android operating system (OS) on your phone or tablet. Hyundai had demonstrated this on a Sonata car at CES 2015, earlier this year, but the bigger news is that, Google has recently released an application program interface (API) that has triggered the race among app makers to begin creating apps for your car.

Apart from minor things like using WhatsApp through your car, Android Auto should allow you to control your phone and car functionality through the now familiar, 'Ok, Google…' command. Google touts in-vehicle messaging as one of the features, but is that really a smart move for the driver?

Apple CarPlay. On the other hand, Apple has its CarPlay that was also featured in Hyundai's Sonata. However, since the API has not been made public as yet by Apple, there is not much to do for it right now. This also means that there will be limited apps upon launch.

Controlling more than just the infotainment system

Of course, Auto and CarPlay are just how regular consumer electronics firms look at this emerging space.

Security. Car manufacturers like Chevrolet and GMC have their own elaborate systems, which include features like over-the-air (OTA) updates for your car, just like your

smartphone has now. This means, new engine-management functions and security features would be just a download away. These software updates in cars even add features like automatic emergency braking and blind-spot warning.

Engine management. What is more interesting is that, in some cars like Tesla, these software updates can increase acceleration, economy or top speed of your car after it gets installed. Expect a day in the future when you can buy car-performance upgrades through app-like downloads, instead of going to the workshop to get the engine modified.

Convenience. Our own *desi* company, Mahindra Reva Electric Vehicles (MREV), has an amazingly connected electric car in the guise of e2o. Users are able to control various elements in their car through a smartphone from anywhere in the world—from turning on the AC to pre-cool the car before you take your family out on a hot summer afternoon, to remotely locking the car and even charging it.

An interesting feature is REVive, which enables the driver to use the smartphone to activate an additional reserve of eight kilometres of range if the car runs out of power.

Safety. Chevrolet is believed to be planning to use its onboard 4G LTE Wi-Fi and OnStar RemoteLink smartphone app to alert owners if their car is about to break down.

Another example is when National Highway Traffic Safety Administration made two recall announcements. While this would normally require owners to bring in their cars to get it fixed, Tesla was able to solve the problem via a simple software update.

Cars can now talk to each other

Perhaps, the first bit towards a world with friendlier cars would be when these can start talking to each other.

Major firms are already running with the idea. GMC already has plans to begin installing vehicle-to-vehicle (V2V) communication in every GMC car.

Nokia announced a US$ 100 million Connected Car fund in May 2015 to drive innovation in connected and intelligent cars.

The month of May also saw the US transportation secretary make an announcement; a mandate proposing all new cars and trucks to have V2V communication equipment will be proposed to the government earlier than expected.

Back in 2006, V2V and vehicle-to-infrastructure (V2I) communication using dedicated short-range communications (DSRC) based on wireless local area network (WLAN) technology were tested by what was known as Vehicle Infrastructure Integration (VII) initiative.

The Federal Communications Commission has dedicated the 5.9GHz frequency band for automotive communication between vehicles and roadside units (RSUs).

IEEE 802.11p is a standard to add wireless access in vehicular environments (WAVE), thus enabling the support of intelligent transportation systems (ITS) applications. It is an amendment to IEEE 802.11, which is the same as the Wi-Fi we all use in our homes and phones today.

"V2V communications is still not mainstream with the Internet of Things (IoT), since many car manufacturers are contemplating the risks associated with it. However, some car manufacturers such as Volkswagen and Audi are working on V2V features for their own cars, such that one Volkswagen may not talk to all cars around it but all Volkswagen around it," explains T. Anand, managing director of Knewron.

He adds, "For all cars to talk to each other, either single protocol or language has to be agreed upon (which is another debate topic for all things in the IoT) or, alternatively, all communication must pass through a broker or translator, which will then make cars another thing in the IoT."

Inter-Vehicular Network Technologies (INVENT), led by Grace Wang from New Jersey Institute of Technology (NJIT), the USA, is developing computing, sensor and networking technologies for next-generation vehicles.

These could gossip, too. These connected cars could very well do the automotive flavour of gossip. This means that these would be constantly swapping basic and minor data that would become useful when a related event occurs, while at the same time giving us an idea of how vehicles in the vicinity are behaving.

Sensor networks and Big Data. Sensors are a very big part of this game. An example is a sensor network across roads, somewhat similar to the ones surrounding some secure areas of Area 51 (a remote detachment of Edwards Air Force Base, within the Nevada Test and Training Range, the USA), which detects motion along the area.

In our case, it could be used to detect animals crossing the road and alert incoming cars to slow down, accordingly. Now, if a vehicle brakes hard, it can use its V2V network to alert other cars in the same lane to slow down urgently; technology like this could go a long way in preventing pileups.

Traffic re-routing and avoiding congestion on the road are other benefits with technology like this. Currently, smartphone users are able to detect congestion along a stretch of road by using applications like Google Maps. Dynamic traffic assignment (DTA) algorithms are examples of technology that could enable people to reduce travel time. However, these lack scalability and robustness and require higher computation time.

The INVENT team also proposed road based vehicular traffic (RBVT) routing, which uses real-time traffic data from vehicles and roadside sensors like the ones mentioned earlier.

Interference in the spectrum. Scott Belcher, chief operating officer of the advocacy group Intelligent Transportation Society of America, stated in a news report on Voice of America

Modern cars allow you to start the engine, turn on the AC and control many aspects of the car from your smartphone

that, "If somehow we are sharing this spectrum and there is interference, then a car that could have prevented the crash would not be able to prevent the crash because someone else is using the spectrum."

Global Automakers, an automotive industry group, is also working to solve the problem of interference by devices that want to use the unlicensed Wi-Fi spectrum currently dedicated to V2V communication.

Cisco Systems has developed a possible way for different industries to share airwaves without such interference, according to a statement from Alliance of Automobile Manufacturers. This is currently in testing as per reports.

Making daily lives easier

New technologies could also alert drivers when it is time to turn left on a highway exit ramp. Now, this sounds pretty mundane and not really a need for most drivers, but, statistics tell a different story. Unsafe left turns account for more than seven per cent of all car collisions, according to an article in Washington Post.

Car manufacturers like Chevrolet are believed to be planning to use their onboard 4G LTE Wi-Fi and OnStar RemoteLink smartphone app to alert owners if their car is about to break down. The device can also aid in scheduling a check up at the dealer to prevent the driver from getting stranded on the road.

The IMPACT lab at Arizona State University, the USA, has been developing formal framework for developing criticality-aware software for continuation-passing style (CPS). Such framework is a promising solution to develop criticality-aware future automotive CPS to save numerous lives.

FPGAs and sensor fusion. Field programmable gate array (FPGA)-powered systems on module (SoM) technology is used in some cases for sensor-fusion applications in automotive.

"One potential application for this would be to integrate this with the car so that it is able to track your face. It would then be able to detect if you closed your eyes, are drowsy or are texting on your phone. Sensors for lane departure could be connected and processed in real-time through this device. In fact, we are already working with one of our customers in Bengaluru on this same system and have even completed the proof-of-concept," explains Bryan Fletcher, technology director, Global Technical Marketing at Avnet, in an interview with EFY.

Google's self-driving car project uses a remote-sensing Lidar (laser radar) system to implement driverless technology.

6D vision technology. LG says that next-generation camera components will allow a driver to transfer some driving tasks to future intelligent cars by monitoring the driver and environment. The cars would be able to sense sign boards, implement lane-changing and do other driving manoeuvres.

LG will also be allowed to use portions of Mercedes-Benz's 6D Vision technology, which will let a car automatically change speed, depending on route conditions and other situations on the road.

Autopilot. Tesla has an impressive self-driving feature called Autopilot, which combines a camera, radar and sonar with real-time traffic data to automatically drive the car. The website explains that, "With Autopilot activated, Model S automatically follows the road, steering around curves and varying its speed to match the flow of traffic. Changing lanes becomes as simple as a tap of the turn signal. When you arrive at your destination, Model S both detects a parking spot and automatically parks itself."

Just like the car-performance upgrade implemented via OTA that we had explained earlier in the article, Autopilot features are progressively enabled over time with software updates. The current software version added automatic emergency braking and blind-spot warning.

Auto manufacturer Ford is partnering with Georgia Institute of Technology for a mobility experiment, Parking Spotter. This project also leverages existing sonar and radar technology already available on Ford vehicles, and uses collected data to map parking information on the go.

The SAM car is an interesting project by a company named Arrow, in which a Corvette car is outfitted to be semi-automatically driven. "Infrared (IR) sensors in the cap worn by the driver provide head position in real-time, which provides data that is used to deduce how much the rotary

actuators should be controlled. These actuators are placed in the steering wheel, gas pedal and brake pedal, and receive commands from the IR sensors," explains Natarajan M.M., vice president for South Asia and Bhartendu Mishra, director - marketing of Arrow Asia-Pacific in an interview with EFY.

"There are also IR cameras that also monitor the driver's subtle head movements. A central processor in the car translates the sensor input into motion commands for the car. It is aided by an onboard global positioning system (GPS) that updates 100 times per second, creating virtual boundaries, and provides data for the car's self-correction in certain cases," adds Natarajan.

An Internet of Vehicles

The Internet of Vehicles (IoV) seems to be a new concept based on the IoT. However, Huawei's website says that, nascent forms of the IoV are already in existence.

"Intelligent transport systems (ITS) in Europe and Japan have adopted certain forms of IoV technology. In New Delhi, all 55,000 licensed rickshaws have been fitted with GPS devices so that drivers can be held accountable for their questionable route selection. China's Ministry of Transport (MOT) had ordered that GPS systems be installed and connected on all long-haul buses and hazmat vehicles by the end of 2011 to ensure good driving habits and reduce the risk of accidents and traffic jams. The Brazilian government has set a goal for all cars in circulation to be fitted with electronic identification (ID) chips from its National Automated Vehicle Identification System (Siniav)."

Huawei also claims that the launch of the US National Strategy for Trusted Identities in Cyberspace (NSTIC) is a milestone for IoV, as it requires that security chips be embedded in all online devices, including those in vehicles.

The telecom connection. In India, Vodafone has partnered with MREV to provide machine-to-machine (M2M) communication services for the e2o range of cars and a central application. A *Times of India* report mentions that, AT&T claimed about 20 million connected devices from cars to cargo ship container sensors in 2014, up 21 per cent from the year earlier. While it has not yet revealed its revenue from its IoT business, the fourth quarter of 2014 saw AT&T adding 800,000 connected cars out of 1.3 million connected devices in its network.

Some exciting technologies

The Mercedes-Benz F105 car we mentioned in the beginning has another impressive feature, in that, its windows are almost invisible from the outside while, the same panels function as TV screens from the inside.

Structural electronics certainly would not make the windows disappear, but it would allow integration of sensors and other components within the vehicle's body and undercarriage. The present implementation of this technology, although at a very basic level, is the highly-sensitive microphones in the very front and back part of some cars that record the structural sound, and in case of an accident, send the signal to the airbag controller.

Could structural electronics be the next big thing in cars, especially when it is biomimetic or imitative of nature?

"It is a fascinating and largely under-explored area right now. Commercial adaptation will probably start with the aeronautical sector—smart-skins, printed electronics, structural super capacitors where the chassis can also act as both load-bearing and energy-storage structure," explains Sandeep Bairampalli, expert on robotics, Robert Bosch Engineering and Business Solutions.

Another innovative use of electronics is with charging. Qualcomm's recently announced Halo Wireless Electric Vehicle Charging (WEVC) technology provides wireless-charging capabilities in a small vehicle package. This will allow users to charge their electric vehicles (EVs) easily and quickly. In addition to that, a supportive tech for Halo, named WiPower, enables consumer electronics to charge wirelessly in-vehicle.

We have all heard of the supercapacitor vs battery debate. Could replacing batteries with supercapacitors be feasible in cars?

"Theoretically, yes. All major organisations are working towards the realisation of this ideal scenario. One focus area of Bosch is electrification; how do we unlock the potential of energy for the benefit of life? Gradually, we will see this happening as the energy density of supercaps increases. We do not have to match the li-ion energy density to see significant market share being taken by supercaps with respect to li-ion, as the power density is much higher and these have significantly higher operational lives," adds Bairampalli.

Is all this safe? "Apart from hacking by third parties, there is a much bigger issue that is now stalling the overall smartcar development; it is cross border data transfer (CBDT).

By law, customer data cannot reside outside the country. And this is a somewhat bigger impediment. Most advanced car manufacturers such as VW, Audi, Mercedes and Toyota do not have local IT infrastructure, and it is usually based at their headquarters (outside India). This means, in order to just make the basic system fully-compliant with law, there is a longer process of infrastructure set up. Then, sharing customer data or even customer's car data with any other customer and privacy concerns raised from those sharing are next-in-line issues," explains Anand.

Is KITT here

Who knows, years down the line we might have something like KITT from the 1982 television series Knight Rider, a robotic car with enough artificial intelligence (AI) that would help it pass the Turing test! ●

Lunar Exploration by Privately-Funded Teams: A New Beginning

Subodh P. Kachhela is a retired scientist/engineer, Space Applications Centre, ISRO, Ahmedabad

Space missions across the world have mainly been funded by respective government agencies. The first phase of private space operation in the USA was the launch of commercial communication satellites, thanks to the US Communication Satellite Act of 1962. Missions for space exploration, however, continued to be government-funded. Historically, SpaceShipOne was the spaceplane that completed the first manned private spaceflight in 2004, which won the US$ 10 million Ansari X prize but was immediately retired from active service.

Augustine Committee was set up to review human spaceflight plans of the USA. In its review, in 2009, it took into account several objectives like support for International Space Station (ISS), development of missions beyond low-Earth orbit (including Mars, moon and near-Earth objects) and use of commercial space industry.

After this, SpaceX (Space Exploration Technologies Corp.) became the first privately-owned company that built unmanned, reusable Dragon Space capsule. The capsule was ferried to space atop the company's Falcon9 rocket launched from Cape Canaveral on May 22, 2012, to dock with ISS. The capsule returned back to Earth after nine days. It delivered supplies to astronauts aboard.

Moon missions by private teams

Specifically for moon exploration, a contest called Google Lunar X Prize (GLXP) has been designed. It is believed that this will boost the role of private companies in other space missions and inspire innovation in spaceflight technologies.

GLXP is igniting a new era of lunar exploration by offering the largest international incentive prize of all time. A total of US$ 30 million in prizes are available to the privately-funded teams. The competition requisites are as follows:

Landing. Safely land a robot (rover) on lunar surface

Moving. Have that rover travel 500m over the lunar surface

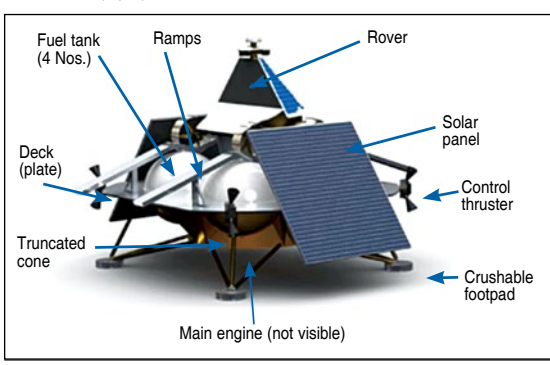
Imaging. Send videos, images and data back to Earth

The teams must be at least 90 per cent privately-funded, though commercially reasonable sales to government customers are allowed without limit.

Approximately 33 teams across the world have been preparing to participate in the competition by fund raising, mission planning and building robots in a new race to the moon. As per the latest information, the deadline for the competition has been extended till December 31, 2016.

Astrobotic and their robots

Prof. Whittaker established Astrobotic Technology at Pittsburg, the USA. He has a rich experience in the field of robotics. His robots explored damaged and dangerously radioactive areas of nuclear power plants, hunted meteorites in the ice fields of Antarctica



Lander-Rover combo for Red Rover (left), and Red Rover (right)

Some of the participating teams and their rovers

and climbed into the craters of active volcanoes in Alaska and Antarctica.

Polaris and Red Rover are the two rovers being developed by Astrobotic.

Polaris, though, may not be a candidate for GLXP; its goal of searching water ice at the pole is interesting. It is designed for drilling at moon's surface on polar region, which is characterised by low-glancing sun angles and near cryogenic temperatures. The rover is tall enough to deploy a 1.2m (4-feet) drill and produce 250W of power with solar panels oriented toward the sun. The rover will also prospect for water, oxygen, methane and other volatiles, which could be useful for energy, supporting life and producing rocket fuel. Astrobotic announced the completion of Polaris prototype on October 8, 2012.

Red Rover, a candidate for GLXP, is a mobile explorer that scouts the moon's mid-latitudes near Equator with cameras and science payloads. It navigates, detects obstacles and captures 3D video footage and maps.

The launch of Red Rover is planned by SpaceX Falcon 9 rocket. After achieving a low-Earth orbit, Falcon 9 stage two reignites for trans-lunar injection (TLI) to propel the spacecraft into a 4.5-day cruise to the moon.

Guidance, navigation and control software (developed at Carnegie Mellon, the USA) will keep the rocket on the right path. Due to lack of a global positioning system (GPS), the vehicle will be guided by plotting its trajectory to the moon by referring to stars, the moon and Earth. Once in moon's orbit, the spacecraft and rover must descend to the moon's surface.

It is interesting to note that Late Astronaut Neil Armstrong piloted the lunar module from orbit to the specific location on the moon, avoiding local hazards like boulders and craters. However, the Earth-to-moon distance imposes a time lag that does not facilitate real-time control from Earth, so the spacecraft's software must accomplish autonomously what Armstrong did manually.

A primary descent engine will burn to slow the spacecraft down as it approaches the moon, while small thrusters will keep the vehicle stabilised. Touching down two days after lunar dawn, Lander will deploy two ramps.

Bolts that hold the ramps folded against the ladder are rigged to break apart under immense heat. After the ramps fall from the spacecraft to the ground, the rover will roll down to the moon's surface. Binocular

Technical Details of Red Rover

Head	Details
Operating environment	Lunar Equator and mid-latitudes, sunrise to sunset with night hibernation
Rover mass	80kg
Payload mass	30kg
Average power	120W (400W peak)
Drive speed	10cm/s
Dimensions (L×W×H)	1.4×1.4×1.7m
Features	Night survival, autonomous roving, passive thermal control, shoulder-driven skid steer, passive rocker suspension, composite chassis, 3D-HD cameras, 4x telephoto zoom camera, direct to Earth communication
Services available	Payload delivery, exclusive corporate sponsorship, HD and 3D video, data licences

eyes (cameras) will scan the ground ahead.

Since moon dust is too slippery to permit an accurate reading of distance travelled based on how many times the rover's wheels have turned, the rover's onboard computer will calculate the distance by comparing the changing appearance of surface features as the robot moves. Radiation-hardened components will protect the computers from unfiltered solar and cosmic radiation with which the airless moon is bombarded.

On ground at Pittsburg, Astrobotic team members shall guide Red Rover to interesting features (hopefully, Apollo landing sites) using low-resolution lunar images. The rover will avoid hazards on the moon's surface autonomously. It will beam high-definition videos as blocks of encrypted data, at least one immediately after landing and one later in the mission to meet X Prize requirements. The rover will also send emails, tweets and Facebook posts.

Challenges for Red Rover

A major technical challenge for the team is to ensure that Red Rover survives the extremes of lunar day and night, each of which lasts two Earth weeks. During the two-week lunar night, the temperature on the moon's surface, where the team plans to land, plummets to -170°C (-274°F). Any component that contains water, such as batteries, would suffer irreparable damage as the water freezes and expands.

The only rover that has survived these extremes of day and night temperatures was Soviet remote-controlled Lunokhods, in 1970s, which relied on radioactive polonium isotope to stay warm. However, Asrobotic and other competing companies do not have access to these materials. To protect Red Rover from the heat of the sun, carbon-filter structures surrounding battery cells conduct heat to the outer surface of the rover. At night, Red Rover will hibernate and will awaken with the sun to fire up non-aqueous lithium-iron-phosphate batteries.

Participating teams

Of the 33 participating teams, Astrobotic has made significant progress, and two purses have already been announced as Astrobotic (the USA) has won US$ 500,000 in the mobility category and US$ 250,000 for their imaging sub-system.

In addition to Astrobotic, other teams competing for milestone prizes are Hakuto (Japan), Team Indus (India), Moon Express (the USA) and Part Time Scientists (Germany), as in December 2014.

It is interesting to note that during the same timeframe (by 2016), India and Russia (joint project) and China (which is building its own rover that will use a radio-isotope to stay powered through the lunar night) may land their rovers on the moon's surface.

What can be gained from GLXP

Perhaps the most enduring benefit of GLXP will be to inspire the next generation of scientists and engineers. Carnegie Mellon's Planetary Robotics Laboratory is entirely dedicated to the moon rover project. They are testing the design for fragmenting metal bolts, an alternative to typical explosive bolts that unhinge the ramps from the spacecraft so that the rover can explore the lunar surface.

Nayaka and a group of undergraduates have prepared a high-speed video camera to record the simulation. After 17.9 seconds of throwing switch, the bolt breaks apart to roll out the rover through the ramp.

For researchers like Douglas Currie, a guaranteed spot for a fixed price on a commercial mission would be a boon. His team wants to place an array of laser ranging reflectometers on the moon to support accurate measurements.

GLXP organisers hope that if they build it, the market will come and, that, developing rovers and getting these on the moon will spur the growth of a new market.

Of course, there has been some skepticism about the competition's viability, and complaints and criticism about the perceived slow pace of progress over the last six years. There is a perceived diminished interest in the moon by NASA, who in 2010 cancelled Constellation Program for a human lunar return and replaced it with plans for human missions to near-Earth asteroids and Mars.

Inspiring, indeed

Even failing to win the prize does not deter some teams, who have visions and business plans that extend beyond the competition.

Richards at SETIcon said, "You know, if another team wins, that is great, too. This is not just about winning the prize. It is about creating a whole new industry. We believe in a long-term vision of opening up moon's resources for the benefit of humanity." ●

Photonic ICs Now Compete With Electronic ICs

Dr S.S. Verma is a professor at Department of Physics, Sant Longowal Institute of Engineering and Technology, Sangrur, Punjab

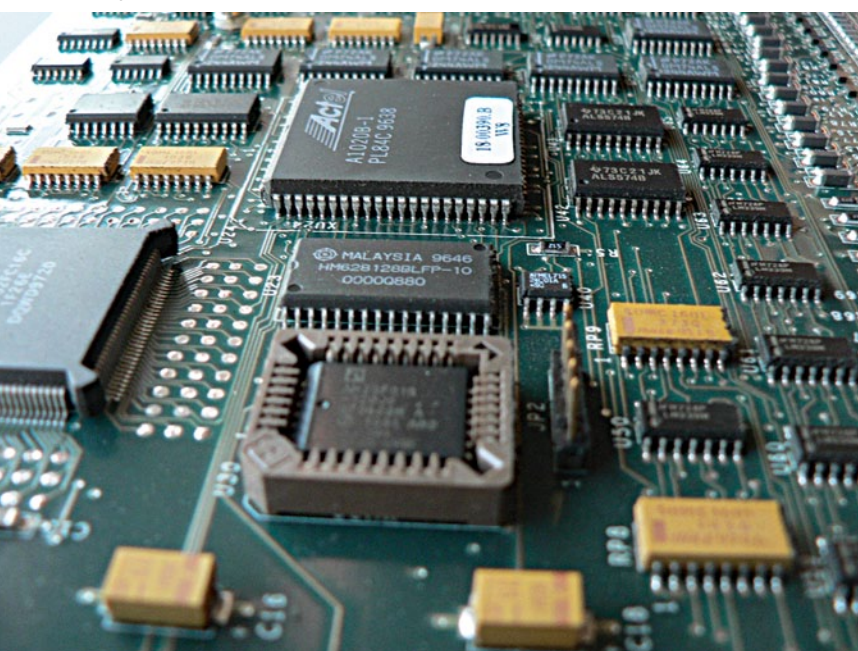
Electronic integrated circuits (Fig. 1) are arguably the most significant technology of the 20th century. In enabling, among other things, the computer industry, these have changed the way we work and play to an unprecedented extent.

Further, integration of nanophotonics and atomic physics has been a long-sought goal that would open new frontiers for optical physics. It is hard to argue at this stage if these kinds of integrated photonic circuits will form the innards of mass-produced devices as integrated electronic circuits have done, but it is just as hard to argue that these never will.

The original inspiration of integrated optics came from the technology of electronic integrated circuits (ICs), which has shown rapid development over several decades and has led to amazing achievements, such as complex and powerful microprocessors containing many millions of transistors, specialised signal processors and computer memory chips with huge data-storage capacities.

In combination with the all-electrical capability to control nano-scale optical circuits, one can envision very exciting opportunities for applications. Photonic integrated circuits (PICs) (Fig. 2) use light rather than electrons to perform a wide variety of optical functions. Recent developments in nanostructures, metamaterials and silicon technologies have expanded the range of possible functionalities for these highly-integrated optical chips.

Fig. 1: An electronic integrated circuit board



Integrated optics is a technology that aims at constructing so-called integrated optical devices or PICs or planar light wave circuits, containing several or many optical components that are combined to fulfill some more or less complex functions. Such components can be optical filters, modulators, amplifiers, lasers and photodetectors. These can be fabricated on the surface of some crystalline material (such as silicon, silica or LiNbO3) and connected with waveguides.

Unfortunately, integrated optics has not been able to match the progress of microelectronics in terms of complexity of possible devices. This results from a number of technical limitations. While electronic circuits can contain extremely-small wires, optical components need to be connected via waveguides, dimensions of which usually cannot be much smaller than the wavelength, and which often cannot tolerate very sharp bends.

Optical connections between waveguides and couplers are significantly more critical than electrical connections. The ability to manipulate atoms with photons in an IC should allow physicists to explore entirely new ways in which matter and light interact.

One possibility pregnant with potential is the ability of light to manipulate and influence individual atoms. Physicists regularly use light to trap atoms and ions in the name of science. This has all kinds of important applications from quantum communication to telling the time. But devices that do all this are well beyond the reach of anybody unlucky enough not to own a well-equipped optics laboratory.

PICs could change that. These offer the possibility of using light to manipulate individual atoms in small self-contained units

that are relatively cheap to make and easy to operate.

Photonic equivalents

A PIC or integrated optical circuit is a device that integrates multiple (at least two) photonic functions and as such is analogous to an electronic IC. The major difference between the two is that, a PIC provides functionality for information signals imposed on optical wavelengths, typically in the visible spectrum or near infrared (IR) 850nm to 1650nm. Unlike electronic integration, where silicon is the dominant material, system PICs have been fabricated from a variety of material systems, including electro-optic crystals such as lithium-niobate, silica on silicon, silicon on insulator, various polymers and semiconductor materials, which are used to make semiconductor lasers such as gallium-arsenide (GaAs) and indium-phosphide (InP).

Different material systems are used because each provides different advantages and limitations, depending on the function to be integrated. Photonic equivalents of these devices have been equally challenging to develop and are widely used to manipulate and control the signals in optical fibres. But, it is fair to say that these have yet to reach their full potential.

Photonic crystals are useful because their optical properties are determined by the physical geometry, size of the waveguide and so on. This allows these to be precisely tuned to carry only certain wavelengths of light.

PIC is a breakthrough technology as it uses photons (smallest unit of light) as data carriers instead of electrons (smallest unit of electricity) used in electronic ICs. As light travels at very high speeds, PIC technology is widely used to transfer huge amounts of data at a very high speed. Thus, PIC based products are primarily deployed in the field of optical-fibre communications.

PICs market is growing at a phenomenal rate as it provides significant improvements in system size, power consumption, reliability and cost. Development of silicon photonics technology has helped in large-scale manufacturing of PICs at a low cost.

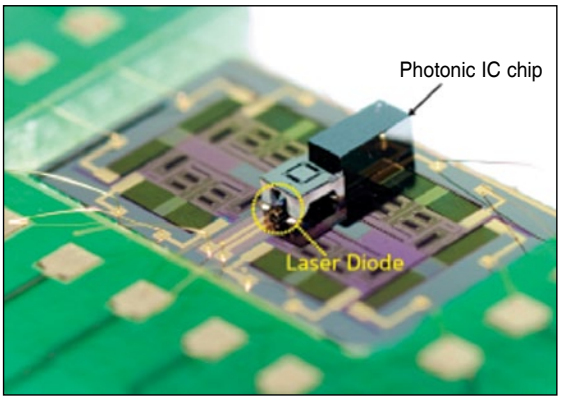


Fig. 2: A photonic integrated circuit (Image courtesy: www.research.a-star.edu.sg)

Also, current leading players have developed monolithically-integrated InP based PICs that can integrate more than 600 components/functions on a single chip. Thus, there is a huge competition in the market as each player is trying to innovate PIC based products, which would be able to integrate large amounts of functions/components at a low cost.

Fabrication techniques

PIC fabrication techniques are similar to those used in electronic ICs, in which photolithography is used to pattern wafers for etching and material deposition.

Unlike electronics, where the primary device is the transistor, there is no single dominant device. The range of devices required on a chip includes low-loss interconnect waveguides, power splitters, optical amplifiers, optical modulators, filters, lasers and detectors. These devices require a variety of different materials and fabrication techniques, making it difficult to realise all of these on a single chip. Newer techniques using resonant photonic interferometry are making way for UV LEDs to be used for optical computing requirements with much cheaper costs, leading the way to petahertz (PHz) consumer electronics.

Development status

The most commercially-utilised material platform for PICs is InP, which allows for the integration of various optically-active and passive functions on the same chip.

Initial examples of PICs were simple two-section distributed Bragg reflector lasers, consisting of two independently-controlled device sections: a gain section and a DBR mirror section.

Consequently, all modern monolithic tunable lasers, widely tunable lasers, externally-modulated lasers and transmitters, and integrated receivers, among others are examples of PICs. Current state-of-the-art devices integrate hundreds of functions onto a single chip.

Some technologists report the development of the first integrated optical circuit with a photonic crystal capable of both localising and interfacing atoms with guided photons in the device. The device is a photonic crystal made of silicon-nitride that acts as a waveguide for laser light to carry light tuned to certain atomic transitions in cesium. When a cesium atom absorbs and scatters these wavelengths, the process generates forces that can be used to trap and manipulate the atom. The photonic crystal is integrated into a system that provides a ready supply of cesium atoms, and the result is an IC capable of manipulating individual cesium atoms.

Recently, the field of plasmonics, which exploits surface plasmons generated when photons hit a metal structure, has opened up the real possibility that photonic circuits could duplicate what electronic ICs do. Previously, photonic circuits were just too large to be functional because of their need to accommodate different wavelengths of light. Despite several advances, plasmons still lost energy too quickly, which reduced the distance these could travel. Now, researchers have developed a solution to this issue by combining graphene and

boron nitride. We can now squeeze light and, at the same time, make it propagate over significant distances through nano-scale materials.

In the future, low-loss graphene plasmons could make signal processing and computing much faster and optical sensing more efficient.

Advantages and challenges

1. PICs can allow optical systems to be made more compact and give higher performance than with discrete optical components.

2. These also offer the possibility of integration with electronic circuits to provide increased functionality.

3. One challenge to achieving this level of integration is the size discrepancy between electronic and photonic components.

4. The emerging field of nanoplasmonics is focused on creating ultracompact components for realising truly nano-scale photonic devices to match their electronic counterparts.

5. PICs should also be immune to the hazards of functionality losses associated with electromagnetic pulses (EMPs), though may not be immune to a high neutron flux.

6. Waveguides, device connections and passive optical components exhibit optical losses, which often need to be compensated with optical amplifiers. These are larger and more complex than electronic amplifiers based on transistors.

7. Some types of optical components can hardly be miniaturised. For these reasons, integrated optical circuits have not reached the complexity of electronic ICs.

8. However, devices of moderate complexity can still be useful, for example, for optical-fibre communications, where these can host multiple data transmitters and/or receivers, consisting of distributed feedback lasers, optical modulators, photodiodes and optical filters, in the form of arrayed waveguide gratings (AWGs).

Growing applications

The primary application for PICs is in the area of fibre-optic communication, though applications in other fields such as biomedical and photonic computing are also possible.

AWG, which is commonly used as optical (de)multiplexers in wavelength division multiplexed (WDM) fibre-optic communication systems, is an example of a PIC that has replaced previous multiplexing schemes, which utilised multiple discrete filter elements.

Since separating optical modes is a need for quantum computing, this technology may be helpful to miniaturise quantum computers.

Another example of a PIC in wide use today in fibre-optic communication systems is the externally modulated laser (EML), which combines a distributed feedback laser diode with an electro-absorption modulator on a single InP based chip. This kind of device will be an important high-quality building block for quantum computation and communication, since atoms can store and manipulate information carried by photons.

However, atoms can also act like other kind of optical components, emitting light with almost perfect efficiency or reflecting it like a mirror. And having many atoms interacting with each other and with photons should provide some interesting experimental opportunities for physicists. The strong interplay between the optical response and large optical forces of many atomic mirrors can give rise to interesting opto-mechanical behavior, such as self-organisation.

An example of the new breed of components is a recently-proposed novel type of bandpass-plasmonic filter that uses a response similar to electromagnetically-induced transparency to achieve multichannel filtering. This allows easy control over filtering wavelengths and bandwidths for applications in wavelength-multiplexing systems for optical computing and communications in highly-integrated all-optical circuits.

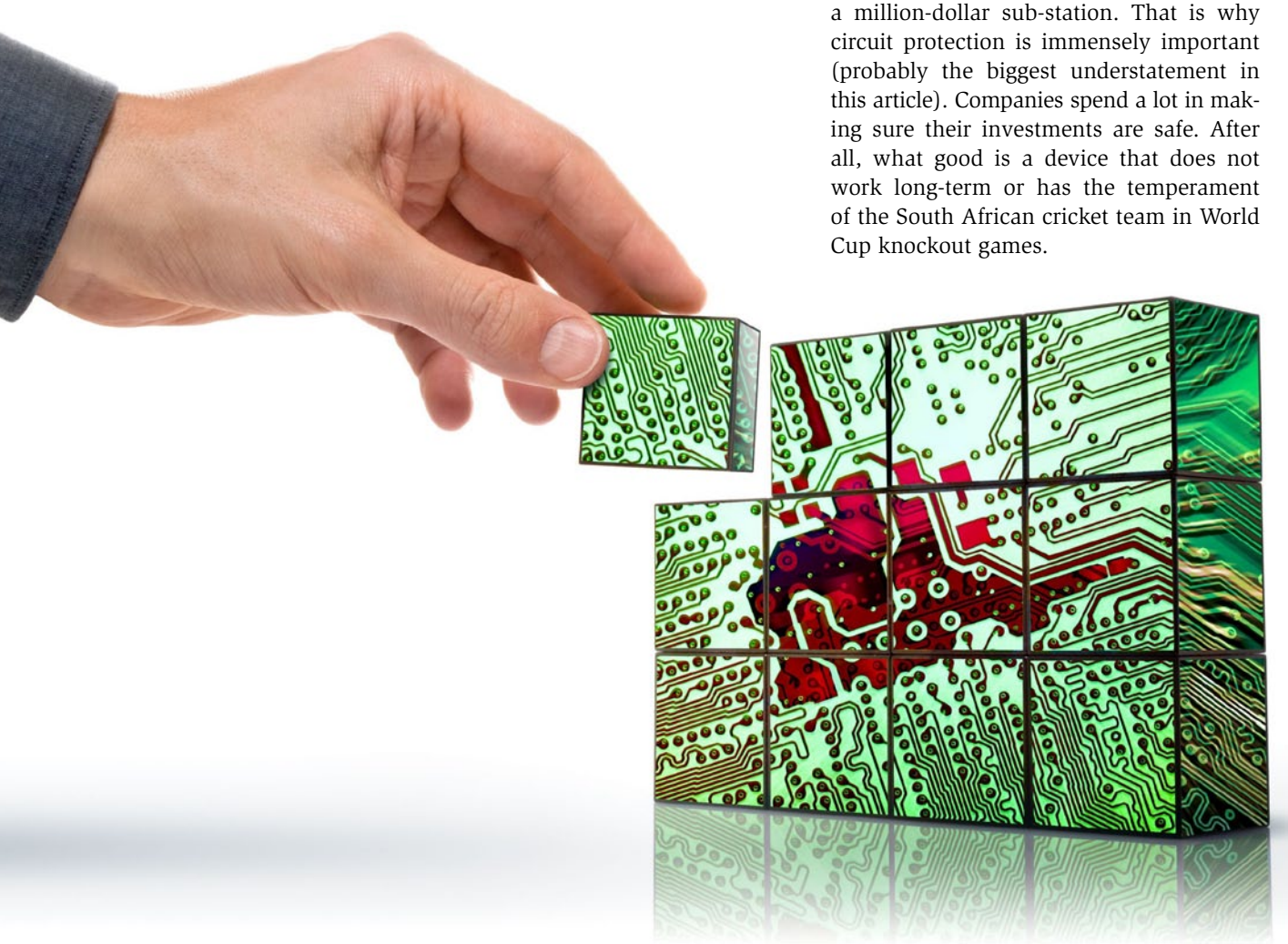
Circuit Protection: Too Important to be an Afterthought

Ashwin Gopinath, an engineer, is currently pursuing MBA in operations from Great Lakes Institute of Management, Chennai

Determining whether a circuit is adequately protected can require a high-level view of the electrical distribution system, from the fault current available at the source of supply down to the end device connected to the system. Circuit protection devices fulfil two primary purposes, namely, safety and reliability. Safety is assured by disconnecting the power in a circuit during over current, which eliminates electrocution and fire hazards.

In addition, the right protection may be necessary to comply with agency standards for some end products. Ranging from the classic fuse to schemes for protection against electrostatic discharge (ESD), these solutions are proof that simplicity still produces the best results. Thanks, freakonomics!

You take care of things valuable to you, monetary or otherwise. You may take care of your first love letter the same way a *Trekkie* would take care of his mint-condition Spock action figure. Closer home, the same level of diligent care is required to protect a small sub-circuit as in protecting a million-dollar sub-station. That is why circuit protection is immensely important (probably the biggest understatement in this article). Companies spend a lot in making sure their investments are safe. After all, what good is a device that does not work long-term or has the temperament of the South African cricket team in World Cup knockout games.



Aspects of circuit protection

If you have watched the movie Interstellar, or are aware of the infamous Murphy's Law, then you know that, anything (bad) that can happen, will happen. Circuit faults can be generated internally because of problems in the system, or can come from external sources. The basic aim of circuit protection is to safeguard against loss of functionality, or degradation in performance, without affecting the core functionality of the system. It has three key elements: protection against mains voltage and its variations, protection against lightning and high voltage transients, and protection against ESD.

Internal problems can be due to over-current events such as a short circuit, or an overload current, and over-voltage events such as short-duration transient voltage spikes or longer duration over voltages. These faults can negatively impact sensitive electronic circuits, if not dealt with on time. External problems can include lightning interference, that induces surges inside the electronics; these travel from outside conductors on the grid to the inside of buildings and homes.

Most products need all three protection schemes, and the intensity of protection varies according to application. For example, if you are developing telecommunication products, your focus will be on mains and lightning. However, if it is a consumer product, the focus will be on ESD.

Srinivasa Moorthy, director, D4X Technologies Pvt Ltd, says, "Many times designers worry about the protection aspect after the design is complete and find out the problems only when the product fails in compliance tests. The key is to understand the compliance and protection needs. It is usually a matter of deriving protection parameters from the standards and implementing protection as part of the design, not as an afterthought. In my opinion, the most forgotten protection is the protection of communication connectors of the product against ESD."

Abhinay Patil, field applications manager - key accounts, Analog Devices India, feels that design engineers need to perfect their workflow and not skip any aspects to ensure an optimum protection scheme. He explains, "There are certain international standards that define the tests an electronics system should pass to be certified as an EMI/EMC robust system, something essential to most products made for the consumer market. These tests include ESD, electrical fast transients (EFTs), surge, radio frequency interference (RFI) and others. The design engineer needs to have knowledge of these standards along with the operating conditions of the product, interference sources and mechanisms through which the interference can get coupled into the system, and the impact of the interference on the system."

Patil adds, "Overlooking any one of these aspects can result in failure to design a truly robust system. Designers also sometimes fail to anticipate non-ideal operating conditions and human errors (like miswirings). So a system that works well in the lab under ideal conditions may fail when installed in the field. Yet another mistake designers may commit is to design the protection scheme only for transient events, while ignoring possible steady state conditions (like high AC/DC voltage on the signal or ground path)."

What is new in this field

Following the trend of going small in electronics, circuit protection has also taken strides in that aspect. New fuse technologies include constructions where voltage ratings and interrupt

Reddit in the house

u/cynar on r/AskElectronics says,

There are four main things to watch out for:

1. Reversed polarity on the power supply. Swapping the positive terminal for the negative will kill many circuits. A diode will work but is inefficient due to both voltage drop and current loss. A p-type metal-oxide semiconductor field-effect transistor (MOSFET) is the best option, but is expensive and needs to be matched to your circuit to an extent.

2. Shorts/excess current. A short to ground can cause a fire in some cases. But even an overloaded circuit can either heat components and connectors or destroy these outright. Best solution here is a fuse or polyfuse (a fuse that resets itself once the problem is cleared). This might not save the chip but it should stop a fire. Again, the value needs to be matched to your circuit.

3. Over voltage. Not generally a problem, but can be in some setups, especially when dealing with spikes. A cap on the input power will smoothen out any short spikes, while a flyback diode will stop spikes from motors coming back into the control circuit. Sustained over voltage is best dealt with a zener diode between the positive and negative terminal. This should be valued so that it only breaks down when the voltage is too high.

4. Static. This is the most painful process in this regard. Your body can build up a huge static voltage in some situations, of the order of 10,000V or more. This will fry many components, even if only applied for fraction of a second. The best protection, in such a case, is pre-emptive grounding of yourself. Touch a grounded metal object before working on your circuit and give the case a good ground if you can. Also, keep components in electrostatic bags until use, if you can (particularly transistors or transistor based stuff).

u/MagnusOre on r/AskElectronics says,

There are a few more things to be looked out for:

On the power bus, there should be reverse polarity protection both on the power input side at DC plug/headers and circuit side rails to ground and over the regulator. Most of the magic smoke I have seen came from reverse polarity, so I wish more people would use reverse polarity-protection diodes and mark the polarity really clearly.

Ex-rated systems use controlled impedances and zener diodes to keep maximum energy in a sensor under control.

While working with digital signals, use isolation devices like optoisolators to eliminate ground loops and massive all-system failure, especially in systems where these cross boards have long wires or go into sensitive converters.

For all devices, as a rule, high voltages should be out of reach of fingers always. This also applies to high energies, like the energy stored in a supercap, just to be on the safe side.

ratings, that were achievable in larger form factors, are now being implemented in smaller surface-mount devices.

Additionally, in over-voltage protection, surge-handling capabilities of larger metal-oxide varistor products are now being achieved in smaller form factors, and even in surface-mount technologies.

A recent practice is to pack together sub-assemblies of a combination of two protection schemes. Natarajan M.M., vice president for South Asia of Arrow Asia-Pacific, explains, "To overcome electrical over-stress (EoS) and to protect equipment from consequent damage, an innovative solution is brought about by hybrid micro-assemblies, also called integrated product devices, in which two circuit protection devices, usually a combination of over voltage (OV) and over current (OC), are packaged together to provide efficient, cost-effective and space-saving circuit-protection solutions."

Patil adds, "A digital isolator is a unique ADI product that helps to form an isolation barrier between two sections of the circuit, namely, the low voltage section (very sensitive) and the other side that is facing the field (prone to damage by unwanted signals). A digital isolator prevents unwanted high-potential voltage from affecting the sensitive portion of circuit by creating a barrier. Another impressive technology is our Latch-Up Proof multiplexers (MUXes)."

He continues, "A latch-up is a condition where a low-impedance path is formed between supply and ground, causing excess current to flow, heating up the affected part and eventually burning it out. The MUX or the switch is typically the first element to get exposed in a signal/data-acquisition system, so one of the ways to protect the circuit is to make this MUX as robust as possible. We do this by using a circuit-design technique known as trench isolation."

Listen up, you

It has been mentioned umpteen times that circuit protection is extremely critical. Let us make that umpteen plus one, with this take by Tim Patel, technical marketing manager, Electronics Business Unit, Littelfuse, "Circuit protection is a critical part of design; it should not be an afterthought. You need to anticipate what faults can occur, what can cause reliability issues, what faults can come into the system that can cause surge events, how a short-circuit event occurs, and what will happen if you do not protect against it. You may need to redo the board layout, costing money and lost development time. You may end up with a less-than-optimal protection device or location, which results in functional failures, poor reliability and safety issues such as shock or fire."

He adds, "Let me tell you a story. Smartphone and tablet industries have evolved so much that chargers are now directly connected to the wall; the wire is just a USB cable. Any short-circuit

MAJOR CONTRIBUTORS TO THIS REPORT

Abhinay Patil, field applications manager - key accounts, Analog Devices India

Ankan Mitra, vice president, SMTA India Chapter

Natarajan M.M., vice president - South Asia, Arrow Asia-Pacific

Srinivasa Moorthy, director, D4X Technologies Pvt Ltd

Tim Patel, technical marketing manager, Electronics Business Unit, Littelfuse Inc.

condition in wall-mount chargers will come directly from the wall into that charger. It is a very dangerous application if you do not have adequate circuit protection. The charger can explode, catch fire or put the other chargers bundled next to it on fire. To solve this potentially dangerous issue, a very small form factor axial fuse is placed inside wall-mount chargers. This is how changing form factors of end devices force small form factors for protection devices, too."

Some golden rules to live by

If you have read up to this point, then you need not be told that circuit protection is quite a can of worms. You essentially have to weigh up risk, cost and consequences. In the end, though, you should not mind spending an extra ₹ 5000 on a circuit that costs ₹ 100,000, as opposed to a circuit that costs ₹ 10,000.

I talked to a host of designers and they all had their own views on what the golden rules are, which must be followed. But within the chaos of opinion, some guidelines did appear a bit more inline than others. Read on to find out if you follow these favourite guidelines of your peers.

According to Moorthy, "Always understand the standards that the product needs to comply with. This is the most significant input for a successful design. Take special care to note the environmental specs, in particular, humidity and altitude. Chances of ESD strikes are higher at low humidity, which can result in complete circuit failure. Increasing chances of lightning at higher altitudes precipitates the need for additional lightning protection to be provided to mitigate the same. I would also suggest working closely with enclosure designers, especially when the enclosure is made of plastic."

Though nothing beats getting the required results in the lab where everything is hunky dory, there is a difference between theory and practical. If not installed properly, protection can end up damaging the thing it was installed to protect. As is now obvious, only the most thorough understanding of the aspects of circuit protection will be helpful in making your designs safe from all harm. At present rate, adoption of ESD, EMI and other phenomena into circuit-protection tools will soon be complete and early adoption of the miniaturised protection devices can only foster future devices with even longer lives. Long live machines!

Little things to remember about little fuses

In choosing the right fuse for a specific application, you need to know the environment in which the fuse is being used. There are several factors used to select the proper fuse.

One is normal operating current. You need to gauge how much steady-state current is going through the system. A fuse has to operate without unintentionally bursting during the lifetime of the circuit. Fuses can weaken over their lifetimes by temperature cycling and by current that causes heating. This causes incremental stressing of the fuse element and can cause brittleness of alloys. As a result, it can cause destruction of the fuse when it is not supposed to; this is called nuisance tripping.

The second factor is application voltage. Fuses are sensitive to changes in current, not voltage. It is not until the fuse element melts and arcing occurs that the circuit voltage and available power become an issue. A fuse may be used at any voltage that is less than its voltage rating without being detrimental to its fusing characteristics.

The third factor is ambient temperature, which can affect the fuse's reliability. Current-carrying-capacity tests of fuses are performed at 25°C and will be affected by changes in ambient temperature. The higher the ambient temperature, the hotter the fuse will operate and the shorter its life. Practical experience indicates, fuses at room temperature should last indefinitely, if operated at no more than 75 per cent of the catalogue fuse rating.

The next factor is maximum-fault or short-circuit current, also called interrupt rating or breaking capacity. A fuse must meet or exceed the maximum-fault current of the circuit. The interrupt rating is the maximum current that the fuse can safely interrupt at a rated voltage. During a fault or short-circuit condition, a fuse may be subjected to an instantaneous overload current many times greater than its normal operating current.

Pulses are another factor. Over its lifetime, a fuse can experience inrush currents that happen on startup. Electrical pulses produce thermal cycling and possible mechanical fatigue that could affect the life of the fuse. For some applications, startup pulses are normal and require the use of fuses that incorporate a thermal-delay design to enable these to survive normal startup pulses, while providing protection against prolonged overloads. It is important to define the startup pulse and then compare it to the fuse's time-current curve. ●

Test and Measurement Tools for LED Lighting

Abhishek A. Mutha is a senior technical correspondent at EFY

In the arena of light emitting diode (LED) test and measurement (T&M), manufacturers are creating many modular T&M devices, which allow for a swift assessment of lighting components and devices. Drivers are an important component in the performance and reliability of LEDs as well. There is a wide range of equipment available in the market for testing just the LED drivers. Let us take a look at some of the latest T&M systems available for LEDs and the lighting segment in general.

Modular, miniature spectrometer for lighting T&M

Miniature spectrometers are enabling new applications and implementations like quality control and product analysis in the lighting industry. These spectrometers provide flexible solutions for a wide range of upcoming applications in the LED industry today.

Fig. 1: Ocean Optics' flame spectrometer

Fig. 2: AsenseTek's Lighting Passport

Developers and manufacturers of lighting solutions harness the power of a spectrometer to solve a variety of problems. Particularly, with respect to LEDs, engineers utilise it in applications that require test-retest reliability in industrial or other environments with varying conditions such as LED binning and process monitoring. Be it LEDs for exterior lighting or just daily quality control of LED production, a spectrometer should measure quickly and be reliable.

With a range of 190nm to 1100nm and a resolution of 0.1nm, Ocean Optics' flame spectrometer (Fig. 1) was announced earlier this year as a device that can be configured to specific application needs with user-interchangeable slits to adjust for varying specifications. These slits allow for variation in resolution and throughput of the spectrometer, as required. Small, rugged and easy-to-use, this spectrometer has a thermal stability of 0.05nm per centigrade up to 650nm range, which is an important feature for LED and other light measurement.

A trend that has been making waves in other test equipment like thermal imagers is the availability of miniature devices that latch on to a smartphone to function in a sort of symbiotic relationship. It seems this trend is catching on in this space too with devices like AsenseTek's Lighting Passport (Fig. 2). It is a professional-grade spectrometer that connects to any smartphone running either Android or iOS, while being small enough to fit in a pocket. There seems to be very little trade-off on functionality, too; firms using this device have worked on projects like Shanghai Formula 1 Racetrack and National Grand Theatre in Beijing.

One device that is often compared to Lighting Passport is UPRtek MK350, which is a somewhat older device, but this also makes it much more mature and tested, and therefore has a lot of positive reviews across the Web favouring it.

Similarly, another handheld spectrometer from GL Optic can be used for research and quality control in the ever-expanding LED lighting industry. This analytical and mobile instrument helps engineers measure a variety of parameters such as luminous flux (lumen), correlated colour temperature, illumination value (lux), colour coordinates and colour rendering

index, to name a few. Unlike Lighting Passport that needs to be connected to a smartphone, the new GL SPECTIS 1.0 (Fig. 3) is a smart spectrometer that requires no connection to a computer or smartphone to take and show measurements. It uses Android operating system (OS) to show critical data such as chromaticity charts and full spectral profile on its touchscreen interface. Boasting of a six-hour battery life, microSD card slot and storage of up to 1000 measurements, this device also looks to tackle fluctuations in temperature with a temperature sensor installed on the its printed circuit board (PCB), providing measurement stability. It is Wi-Fi- and USB-2.0-enabled.

Meeting demands

This high-end spectrometer was created to accommodate the demands of production control in the manufacture of LED lamps or chips, and also conform to the requirements of international lighting standards such as CIE 127:2007 for LED measurements.

CIE 127:2007 defines capabilities for determining radiometric and photometric quantities such as total radiant flux or partial LED flux. It also defines Illuminating Engineering Society of North America's (IESNA) LM-79-08 standard that describes procedures to perform reproducible measurements of electrical power, total luminous flux, luminous intensity distribution or chromaticity of solid-state lighting products.

GL SPECTIS 6.0 from GL Optics comes in a rack-mountable format that supports measurements in an extensive spectral range of 200nm to 1050nm, covering from ultraviolet (UV) to near infrared (NIR) range with a resolution of 3.5nm.

A key characteristic of LED lighting is the computation of energy efficiency in comparison to conventional light sources. Using luminous efficacy (measured in lm/W), efficiency is determined by quantifying spectral characteristics of respective luminous elements, assessed mainly on the basis of luminous flux and radiant power. These measurements can be made by coupling this spectrometer with an integrating sphere from GL Optics such as GL OPTI SPHERE 500.

Making accurate measurements over a range of intensities

As light measurement is mostly about data, it is essential to have a device that can accurately collect data over the broadest range of light intensities possible.

International Light Technologies (ILT) recently released ILT5000, which is a combination of radiometer, optometer and pico ammeter. Making possible rapid measurements up to 100Hz and wider dynamic range from 100fA to 1mA, this device supports numerous light-measurement applications. Key features included are faster data transfer, broader calibrated range, wireless connectivity, 4mA to 20mA output and easy-to-use software. The automatic-ranging feature enables rapid switching through all current levels.

Available in wired and wireless versions, the broader dynamic range of this device coupled with SubMiniature version A (SMA) input connector enables it to also function as a pico ammeter. ILT5000 comes with a detachable antenna that allows it to send data at the rate of 16 readings per second. As with almost any new measurement device manufactured today, this instrument comes with a mini universal serial bus (USB) port for powering the device, data transfer as well as battery-charging purposes.

Photometers are widely used in the development and testing of lighting, LED and in-vehicle lighting applications. With better cameras embedded inside photometers, these can provide a wider dynamic range, thereby reducing image-noise levels. See the difference in Figs 5 and 6.

LM-80: A standard to make LED products standout

Standards ease the evaluation and comparison of LED components, luminaries and lamps. LM-80 is one such standard. Before the arrival of LM-80, LED manufacturers measured lumen depreciation using their own contrasting systems.

Members of Illuminating Engineering Society (IES) created LM-80, a standard methodology that allows customers to compare lumen maintenance of LEDs from various companies. Tom Juel, inside sales representative, CSA Group/Orb Optronix, feels that LM-80 is not a required test for LEDs, but it is highly recommended in order for a company to differentiate its LEDs from its competitor's.

LM-80 is a test that determines the LEDs' expected lifetime under various conditions including temperature and drive currents. The world standard to determine the LED lifetime performance is by running LM-80 data through TM-21 calculation. Juel says, "Our own LM-80 thermal chambers are modular, allowing our laboratory to expand as needed, without long lead times as we build more space. This scalable system is important as demand for more testing at longer durations and multiple temperatures continues to increase." He adds, "Other LM-80 systems require large ovens that hold a population of LEDs at one temperature. With our test chambers, a user is able to control multiple temperatures across the system."

Fig. 3: GL Optic's GL SPECTIS 1.0, a handheld, Android based, smart spectrometer

Point of view: No significant changes in LED testing hardware

LED testing hardware has not changed much in recent years. However, the changing demand within the industry has helped companies innovate and improve their software. All products that we sell are used within our own testing laboratory every day. This helps us to develop our software continuously to help tackle more capabilities as we see fit. We have also worked with our customers to help implement metrics they find important into our software.

—Tom Juel, inside sales representative, CSA Group/Orb Optronix

Analyser that could reduce LED testing time by 90 per cent

The life and light quality of LEDs has always been heavily influenced by its thermal performance. A high-tech research and development (R&D) institution, Industrial Technology Research Institute (ITRI), has developed an automatic thermal analyser that provides a measurement speed of 12,000 LEDs per hour, against traditional lab methods that offer a measurement speed of six components per hour. Touching such high thermal-resistance measurement speeds minimises the component thermal-resistance testing time of an LED to 0.3 seconds. While offering a significantly decreased testing time, InLine Compact Thermal Analyser (ICTA) aims to enhance production yield, performance and lifespan of LED devices. It uses a high-speed temperature sensitive parameter (TSP) measurement technique that looks to reduce LED testing time by more than 90 per cent.

After receiving the 2014 R&D Award, ITRI's ICTA has also bagged Frost & Sullivan's Best Practices New Product Innovation Award for 2015.

Fig. 4: ITL5000 research radiometer

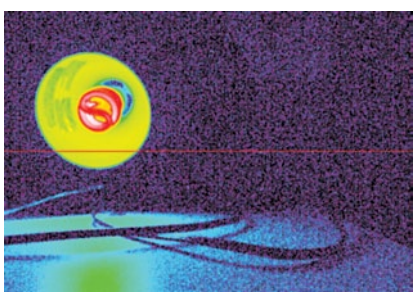


Fig. 5: High-dynamic-range mode turned off

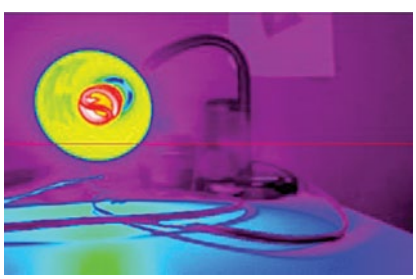


Fig. 6: High-dynamic-range mode turned on

For very high accuracy measurements, SphereOptics introduced a new feature known as high-dynamic-range (HDR) mode for their I-Series and Y-Series ProMetric imaging photometers. For a more accurate luminance analysis, this feature can be used on a device under test to attain the lowest and highest light-illumination levels. Considering streetlights as an example of the device under test, HDR mode in I-Series and Y-Series ProMetric imaging photometers can be used to measure the illumination pattern and light directly emitted from these.

Another imaging-measurement system for quick recording of colour distributions and luminance, Konica Minolta Sensing Americas' (KMSA) and Instrument Systems' LumiCam 1300 Advanced can be used particularly for narrow-band LED colour-light measurements in today's controls and displays to meet extremely high requirements. It boasts of a unique camera concept, which uses two filters having six optical filters in total.

Lighting professionals can make use of this concept for highly accurate measurements while analysing the characteristics of display and control elements in vehicles, flat electronic display screens, and generic lamps and luminaries used in a number of industries including aerospace. This photometer and colorimeter gives the current range of spectro-radiometric tools in the market a run for their money.

Tools to test LED drivers

Some interesting systems in the market from Chrome Instruments (Fig. 7) for testing drivers include high-precision power meters, programmable DC and AC sources and LED load simulators specifically designed for LED power drivers.

With output powers ranging from 500VA to 2000VA, the 61500 series programmable AC power sources offer three different modes, namely, AC plus DC, AC and DC output modes. These feature parameters such as measure peak and inrush current, root mean square voltage, current, power, crest factor, power factor, volt-ampere, volt-ampere reactive with programmable voltage and frequency slew rate.

On the other hand, the Chroma 66200 series are digital power meters with a wide range of power, voltage and current parameters. A user-defined benchmark provides automatic pass or fail indications, and total harmonic distortion (THD), inrush current and other energy measurements are available.

For companies into volume manufacturing of LED drivers, fixtures and arrays, it is important to verify the quality of their production swiftly. Time-to-market is an important factor to keep in mind, apart from improving product performance, validating its design and quality.

As the name suggests, ASE Test's SSL 3.0 Test System (Fig. 8) is industry's first automated test system for solid-state lighting products. It is basically used for design verification, volume manufacturing testing and performance validation. It tests DC-driven LED arrays, AC-driven LED

Fig. 7: High-speed DC electronic load from Chroma Instruments

Fig. 8: ASE Test's SSL 3.0 Test System (Image courtesy: www.ledtimes.com)

Fig. 9: Chroma's 58158-SC LED lighting inline test system

drivers and LED fixtures across multiple voltages and load capabilities in 10 to 20 seconds. Manufacturers can fulfil six-sigma certifications for their products with statistical process control (SPC) delivered by this system. To help construct industry standards, this testing system also creates defined testing parameters and benchmarks for LED light engines, drivers and systems.

A test system for LED bulbs, lamps and other luminaries

This LED lighting inline test system focuses on production-line tests. Apart from basic measurement, other processes such as data collection and analysis, integration of production line and automated calibration highlight the advantages of using this system, in addition to optical and electrical T&M such as total luminous flux of LED lamps (lm), correlated colour temperature (CCT), colour rendering index (CRI), power factor (PF) and luminous efficacy (lm/W).

Spatial distribution and flicker measurement characterisation are two of its core techniques. By using the angle between the LED lamp and solar cells as well as the measured parameters from solar cells, it can calculate the distribution of the optical field of the LED lamp. It can also perform measurement of a flicker of an LED lamp with the help of high-speed response of solar cells.

This test equipment is suitable for different types of LED lamps. A special module is used to measure the luminous flux of inconsistent shapes or multiple sizes of LED lamps. This equipment is also easy-to-integrate with other automated systems to observe and increase test speed and reduce measurement cost to carry out automation on production line.

Point of view: How PXI accelerates LED testing

Traditionally, multiple instruments were used for carrying out a single characterisation test. PXI provides a single platform with multiple instruments in a single chassis, which is capable of providing multiple kinds of inputs and acquiring multiple variations in outputs from device-under-test (DUT), thereby encompassing all necessary test procedures. For example, to test for ideal characteristics of an LED bulb, a particular voltage needs to be applied and the current flowing through the LED must be monitored, thereby plotting its IV characteristics. For this, an AC voltage generator or power supply and a separate measurement device are needed. We have replaced this approach of using two separate instruments for measurement with a single unit called source measurement unit (SMU).

The latest module, PXIe4141 SMU, which we came up with, contains two different technologies. One is called source adapt technology, which speeds up the complete characterisation test as it allows customisation of the SMU's response to any type of load.

The other technology is the capability of pulse power. SMUs are also capable of handling a very high power rating for a very low duration of time known as pulse power. Here, these source an amount of current, which is generally not under the specification, for a certain amount of pulse, and during that time, SMUs also complete the test in real-time. Therefore you can complete the overall test for a high power using an SMU that has low power capabilities in a short duration.

—Avichal Kulshrestha, technical marketing engineer, National Instruments

Pricing trends

Price trends for test equipment have been going up, but not by much. We fight to keep our pricing the same; however, our suppliers raise the price for components and sometimes we are forced to raise our own. I cannot speak for our competitors, but added features are not the cause for rising prices.

—Tom Juel, inside sales representative, CSA Group/Orb Optronix

Sorting and binning LEDs with a spectral meter

In the industrial manufacturing of LEDs, based on colorimetric and photometric specifications, sorting and binning LEDs generates challenges in measurement parameters such as accuracy and speed. Apart from error-free synchronisation of the spectral meter with the existing system operation, it is highly important for the measurement device to accurately obtain results and transfer the data in the shortest time possible.

Gigahertz-Optik's BTS2048-VL spectral light and colour meter is best suited for online production applications for radiometric, colorimetric, photometric and spectral-radiometric measurements. It provides a speedy response time over a broad dynamic range using three processors and electronic shutter, coupled with input and output triggers for synchronised LED-binning applications. ●

Basic User Interface Design for Electronics Engineers

S.A. Srinivasa Moorthy is director, D4XTechnologies Pvt Ltd, Chennai

An engineer studies electronics at the bachelor level, and what he or she learns are the fundamentals of electronics and how to use these for designing circuits. However, when the engineer joins a company, most of the times, he or she gets to work on real-life products, which are completely different from the circuits that are designed in college, as full product design is a completely intense process where users of the products take the primary position in defining product features.

Structured development process

A typical product design has well-defined steps, and the first phase is called concept phase. Large and experienced product companies follow a structured development process. One of the key things that structured product development demands is usability study, which helps product designers to define the shape and size of the product, along with its user interface (UI). The depth of study varies from company to company.

However, if the product is for use in medical, avionics and other safety-critical applications, usability study is critical and needs to be carried out in detail, covering all possibilities to ensure that the UI does not cause wrong usage of the product or introduce errors. Since usability engineering or UI design (UID) is a specialised area, it often requires special training. Engineers who are trained in UID are called industrial design (ID) engineers. They are trained in aspects like usability, ergonomics and visual cues, among others.

Large companies have specially-trained designers for UID. Smaller companies find it difficult to hire their services as these are expensive. This article aims to help designers who work in smaller companies, as well as professional electronics designers, to design products with essential UI features in their designs. A typical UID has two essential parts:

1. Basic UI rules, which are mandatory in most products

2. Special needs depending on product categories like consumer, safety critical, medical and avionics, which need professional help in designing the UI

What we will see here are standard UID inputs, which will help designers meet the bare minimum UI needs. While this is not exhaustive content, it is good enough to meet the needs of small products, which have no critical-safety functionality requirements.

Usability study

Usability study is a process where ID engineers create product mock-ups (in most cases) and test these with prospective users for feedback. Typically, they create four to five variations to get a feel of what the end customer wants. Spreading the features across three to four mock-ups, instead of putting all features in one, ensures that users will not get overwhelmed and shall provide the feedback in an objective way. This type of study reveals some critical aspects of the product, such as:

1. Shape and size of the product (especially, if the product is handheld or portable)

2. A keyboard, its functions and layout

3. An output devices like a display or an alarm, and its relationship to an input device like a keyboard, knob or lever

4. Sequence of product functions and how users interact with the product

In all these, the focus is on UI so that the user does not commit any induced errors.

Industrial designers are trained to use the mock-up or, sometimes, the functional prototype of the product itself to elicit feedback from prospective users and use the

feedback to refine the UI. Usability study for some critical products can go through three to four iterations before freezing on the final one. Over a period of time, this practice has matured and, with experience, it has generated two streams of output for designers:

1. Standard design inputs, which are common to most products, are related to UI components like keyboards, displays, knobs and levers, their layout and grouping, and can be categorised as must-have features.

2. Product specific inputs, which need special design inputs depending on product functionality (for example, touch based slider for volume control), need to be specially assessed by ID engineers.

In this article, we will see some of the must-have features specially related to keys and knobs, among others. These inputs will range from selection of parts to location and colour to be used. These inputs will help designers of small products and designers from small- and medium-size company designers to have a low-cost but acceptable UID. However, they need to be careful about one point; if their designs are applicable to safety-critical industrial systems and medical devices, getting help from professional designers is a must.

Basic usability engineering (UID)

When a human being interacts with a machine (product), there are three types of interactions that take place:

1. Human-machine
2. Human-workspace
3. Human-environment

A good UI will balance the impact of all these equally and ensure that the user is not adversely impacted while using the product.

Let us see what each of these interactions mean to designers.

Human-machine. This interaction involves the influence of the product on the user and his decisions on displays, controls, panel layouts, rate of information dissemination, etc. Essentially, it means how users react to the product's UI when they are interacting with the product.

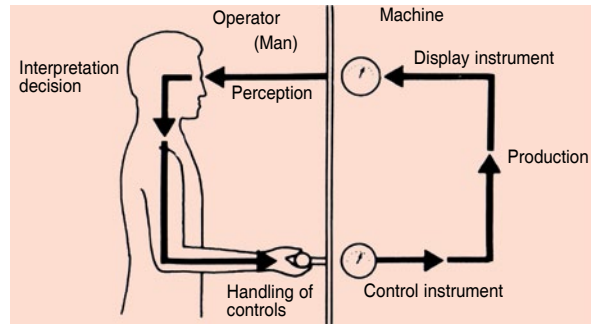


Fig. 1: Relationship between a human being and a machine

Human-workspace. This interaction involves the user, his or her posture, position, how much he or she has to reach out to use the product, product size, structure of the product, and so on. Essentially, this means the impact on the user, especially physically, while using the product.

Human-environment. This interaction involves the behaviour of the user based on the working environment like light, temperature, sound (acoustics), noise, ventilation and radiation. Essentially, this deals with the environment in which the product works and how that will impact the user.

A good example can be an industrial control system with an audio alarm on a noisy shop floor. Normally, the user in this environment will use earplugs to muffle the sound (noise). So if the product has to work in an environment like that, he or she needs to use a visual alarm along with an audio alarm.

UI-human interaction chain

A good UID is a closed-loop feedback design. Fig. 1 shows the relationship between a human and a machine.

When this loop gets disrupted, external errors happen. While we normally call this human error, the trigger is from the external world. This means that the display and controls of a system (product) need to be designed in a way that induced errors are minimised or removed completely, wherever possible.

With this background, let us look at the types of user interactions and types of users for better understanding of UI design.

Human-machine interaction types

1. Conventional systems or products with switches, keyboards, displays and alarms

2. Computer interface, which is also called human-computer interaction (HCI); typically uses keyboards, touchscreens and monitor displays

Types of users. Users are classified into three categories:

Novice. Someone who is a first-time user of the product (has less exposure to the product)

Expert. Someone who has used the product earlier (knows how to use the product)

Casual. Someone who can use the product; may not be as well-versed as an expert, but would have been exposed to other similar products

This means UID actually needs to cater to the types of usage, as well as the types of users, to be successful. Having understood the usage and user types, let us now see the actual design of a UI and components used for the same.

Essential UIs

For a design engineer, an important element of the UI are keys. Let us understand the design using these.

Controls (input devices). These include switches, potentiometers and valves, among others, and can be further classified into two groups:

Discrete controls. Each position in a switch represents a separate function, and switches are typically discrete controls. Fig. 2 shows some of the discrete control elements.

Continuous controls. Continuous controls change in value from a minimum to a maximum. Rotary valves, potentiometers and rotary switches are good examples of continuous controls. Fig. 3 shows some continuous control elements.

TABLE I
Different Types of Switches and Their Suitability for Different Application Needs

Control type	Suitability for tasks involving:			
	Speed	Accuracy	Force	Range
Push button	Good	Unsuitable	Unsuitable	Unsuitable
Toggle switch	Good	Unsuitable	Unsuitable	Unsuitable
Rotary selector	Good	Good	Unsuitable	Unsuitable
Knob	Unsuitable	Fair	Unsuitable	Fair
Small crank	Good	Poor	Unsuitable	Good
Large crank	Poor	Unsuitable	Good	Good
Wheel	Poor	Good	Fair/poor	Fair
Horizontal lever	Good	Poor	Poor	Poor
Vertical lever (to/from body)	Good	Fair	Short: Poor Long: Good	Poor
Vertical lever (across body)	Fair	Fair	Fair	Unsuitable
Joystick (lever)	Good	Good	Poor	Unsuitable
Pedal	Good	Poor	Good	Unsuitable

Fig. 2: Some discrete control elements

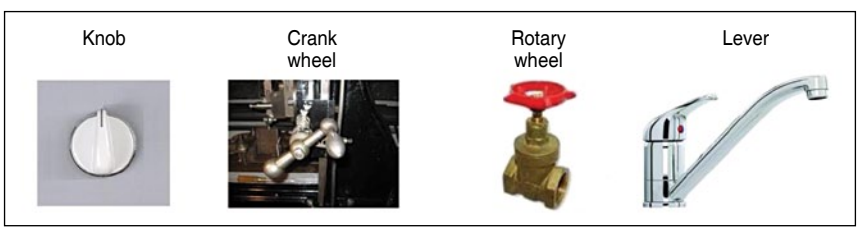


Fig. 3: Some continuous control elements

Effective controls have four important characteristics:

Accessibility. A control needs to be located in such a way that it can be reached easily and operated comfortably.

Identifiable. A control needs to be identified in terms of what it does in order to operate.

Functional. What a control controls and currently in what state it is needs to be indicated to the user when he or she looks at it. For example, a power-on toggle switch indicates whether it is on or off. This is useful especially when the product does not have a display.

Usability. A control should be easily usable with required force, speed and accuracy. This aspect is very critical, especially in continuous control, where a system's response is dependent on the control of the overall system.

Table I gives a concise view of the different types of switches and their suitability for different application needs.

With the availability of powerful processors and low-cost display technologies, a new input device available these days is the touchscreen, where keys are actually images created by graphics, and the overlay touch mechanism, combined with the software, gives key-like input.

In addition to regular pushbutton switch based keys and touchscreens, another option that is available is known as membrane keys. These are made of PVC sheets of membrane with conductive elements sandwiched to form the key mechanism. The advantage of these keys is their form and shape that can be customised. Their low profile can be less than 1mm thick. Fig. 4 shows the types of membrane keys available and their construction.

While we have seen some critical design inputs, we also need to understand the basic characteristics of different switch types. There are four essential characteristics of switches:

Key size. Determines the ease with which fingers can be used.

Tactile feedback. Feedback that the user gets when the switch is closed, either by Click sound or haptic feedback to the finger pressing the switch.

View. Ability to view at night (whether keys can be illuminated or not).

Number of operations. A very important parameter that most designers miss out. Designers have to estimate the approximate number of times the keys will be used. Based on that estimate, the type of keys can be selected.

Mechanical keys tend to have large operating cycles, while membrane keys have the least. Many designs have failed due to the wrong usage of keys.

Table II gives the minimum distance that we should have between different keys as a matrix. This can help designers decide the spacing between different types of controls/switches by specifying various combinations of different switches.

Described below are the three types of keys:

Mechanical keys. These keys typically come in standard sizes and are excellent in terms of operational life and reliability. Depending on the working environment, the proper type

TABLE II
Minimum Distance between Different Keys as a Matrix

Switch type	Push button	Push button array	Legend switch	Slide and rocker switch	Toggle switch	Thumb wheel	Rotary switch	Large J handle	Small J handle
Push button	13	50	50	13	13	13	13	152	76
Push button array	50	50	50	38	38	38	50	152	76
Legend switch	50	50	50	38	38	38	50	152	76
Slide and rocker switch	13	38	38	13	19	13	13	127	50
Toggle switch	13	38	38	19	19	13	19	152	76
Thumb wheel	13	38	38	13	13	13	19	127	50
Rotary switch	13	50	50	13	19	19	25	127	50
Large J handle	152	152	152	127	152	127	127	76	127
Small J handle	76	76	76	50	76	50	50	127	25

Note: All measurements are in mm

should be selected (if the environment is dusty or humid, a sealed switch should be used). These come in different sizes and with/without tactile feedback. Since these keys typically come in two parts, main switch and key top, customisation and changes can be easily implemented.

Membrane keys. Membrane keys are the sleekest and can only be custom-designed. While their design is fairly straightforward in terms of usage, these have some restrictions. Since these keys are very thin when placed in a keyboard, it is hard to identify different keys (so old people or visually-challenged users will find it difficult to use instruments having such keys). Also, tactile feedback has to be incorporated in the design itself, and sometimes this needs special processes, as plastic films have to be moulded.

One big challenge is the amount for force that is needed to operate these keys, which is much higher than mechanical keys. These keys are prone to fail when tactile feedback is absent.

Touch keys. These keys are formed with a combination of hardware and software. Typically, the display itself becomes a keyboard with a touch-key overlay and graphics displayed in the display.

There are three types of touch technologies that are in use: 4-wire resistive, 5-wire resistive and capacitive. Table III captures their characteristics for a better understanding.

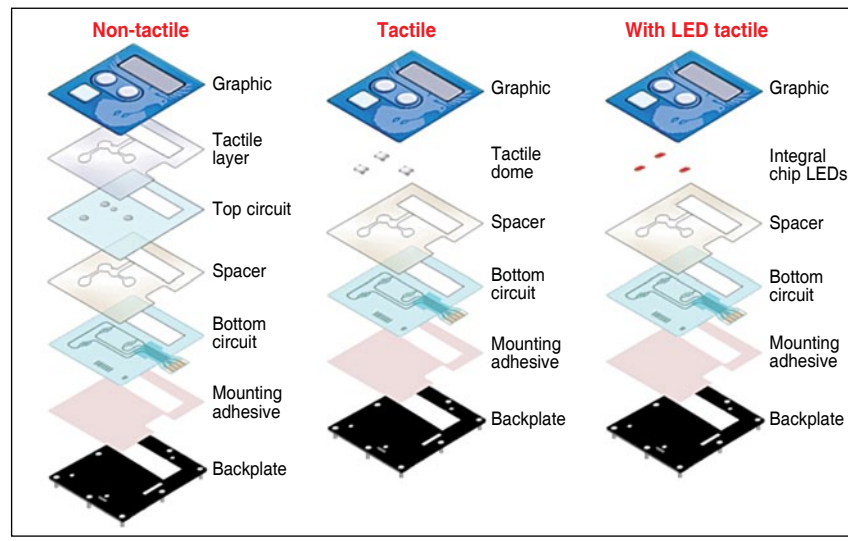


Fig. 4: Types of membrane keys

Some advantages of the touchscreen are:

1. Points directly to objects; there is a direct relationship between hand and cursor movements (distance, speed and direction)
2. Intuitive to use
3. Since the hand is moving on the same surface as the cursor, manipulating objects on the screen is similar to manipulating these in the manual world
4. Fast, but less precise without a pen
5. A finger can be used as well, apart from a pen (usually no cable is needed)
6. No keyboard is necessary for applications that need menu selections only, and this also saves desk space
7. Suitable for novices, applications for information retrieval and high-use environments
8. Is adaptable; since the keyboard layout is software-generated, it is much easier to support different languages (one reason why ATMs use touchscreens)

There are some disadvantages too, which are as follows:

1. Low-precision (finger): Imprecise positioning, possible problems with eye-parallel axis (with pen, too); the finger may be too large for accurately pointing at small objects (a pen is more accurate)
2. Hand movements (if used with a keyboard): Requires the user to

TABLE III
Touch Technologies and Their Characteristics

Technology	4-wire resistive	5-wire resistive	Capacitive
Durability	Three years	Five years	Two years
Stability	High	High	OK
Transparency	Bad	Bad	OK
Installation	Built-in/on-wall	Built-in/on-wall	Built-in
Touch	Anything	Anything	Conductive
Light-resistant	Good	Good	Bad
Response time	<10ms	<15ms	<15ms
Following speed	Good	Good	Good
Excursion	No	Big	Big
Monitor option	CRT or LCD	CRT or LCD	CRT or LCD or LED
Waterproof	Good	Good	Good

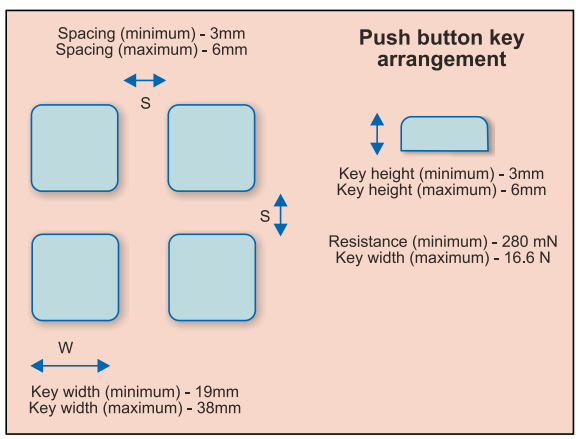


Fig. 5: Design input for a push button

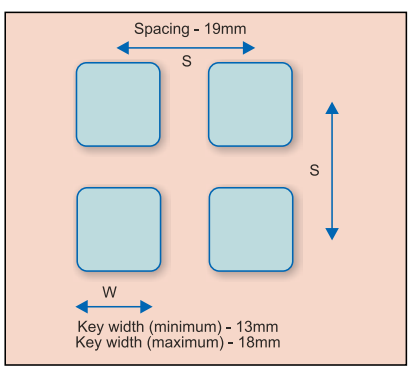


Fig. 6: Design input for a touchscreen

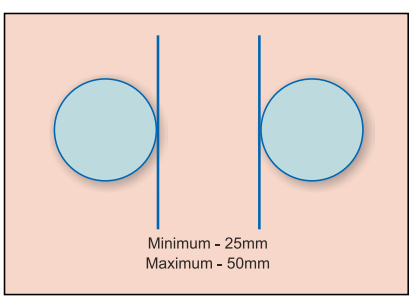


Fig. 7: Design input for spacing between knobs

move the hand away from the keyboard; a stylus also requires hand movements (to use the pen)

3. Fatigue: Could strain arm muscles after heavy use, especially if the screen is placed vertically. Also, the user has to sit/stand close to the screen

4. Dirt: The screen gets dirty from fingerprints

5. Screen coverage: The user's hand, finger or pen may obstruct parts of the screen

6. Activation: Usually direct activation of the selected function, when the screen is touched; there is no special activation button as in the case of a light pen or mouse

Some design inputs, especially the spacing between different types of keys to be used, are given in Fig. 5 for a push button, Fig. 6 for a touchscreen and Fig. 7 for spacing between knobs, for designers to follow.

Let us now look at displays, which are an integral part of the UI. A UI is complete only when input (keys) and output (displays) go together.

Some displays used in products and design inputs for these are discussed next.

Displays and output devices. In an electronic system, displays can be classified into four major types:

Dials. These have graduated scales on which the indication of a value is shown by a pointer. An advantage of the dials is that these give the relative status of the product by showing where the needle is, as compared to full scale.

Warning devices. Warning displays call for attention and require action. For example, a red traffic light means that you must stop your vehicle.

Indicators. These displays have no graduated scales, but display text or numeric information, to show the state of a system. A good example is a digital panel meter, which shows the reading but never tells the maximum or minimum, unless explicitly mentioned.

Counters. Counters show the information directly as numbers.

Based on their functionality, displays can be grouped into three major categories:

Quantitative displays.

1. These display exact information. Digital quantitative displays present information directly as numbers. An example is a digital clock.

2. Analogue quantitative displays can also be used where the length or angle represents the information. For example, a thermometer where the column of mercury or alcohol represents temperature.

3. Use of a particular quantitative display depends on the kind of information that is required. If you need a precise reading, then digital indicators are most easily read.

Qualitative displays.

1. These displays give information about particular states, for example, hot or cold, alarm or no alarm, etc. These can provide information about the rate of change or direction of deviation from a desired value.

2. These displays may include indicators and warning devices, and can be used in circumstances where you only need to know whether a certain condition exists. For example, when temperature of

a steam iron becomes too high, it switches off, which is indicated by a small red light (bulb) that goes off.

Representative displays.

1. These displays can portray either working models or simplified diagrams of a complex process, system or machine. These enable the perception of the functioning of each part of the system or machine in correct relation to the whole system. Most underground rails (metros) and ordnance survey maps, railway signal panels and plant mimic diagrams are examples of these displays.

Now, let us see the factors that impact displays when these are used in products. When displays are combined with input devices, the challenges are many. Some key elements are:

Viewing distance. This is the distance from where users can read the display and operate controls. Typically, distances vary from 300mm to 750mm. Any distance beyond this will strain the user.

Illumination of displays. LED based devices have built-in light emission and, hence, illumination is easy to control. However, when the product uses liquid crystal displays (LCDs), the design becomes complex. While some LCDs are reflective and need external lights to work, other LCDs work with backlights, the intensity of which is key for display illumination. Designers need to choose the right illumination, depending on external light availability where the product will be used.

Viewing angle. This is a critical parameter, which most designers miss. The best view is possible when the user is at 90° to the display plane (right in front of the display).

Viewing angle of the display can be defined as the angle at which the display will be legible from the 90° position. LCDs have a restricted viewing angle (typically about 20° to 30°). Higher the viewing angle, better the viewing, but greater the cost.

Also, when the LCD is mounted in a slanted position, the viewing angle should be with respect to the slant. This angle of slant is important when keys are mounted along with the display. Table IV gives the illumination needed for different displays and other work-related areas.

TABLE IV
Illumination Needed for Different Displays and Other Work Areas

Work areas or objects viewed	Lighting needed (lux)
Panel and primary working areas	540
Auxiliary panels	540
Scale indicator readings	540
Seated operator stations	1080
Maintenance and wiring areas	540
Emergency operating areas	110

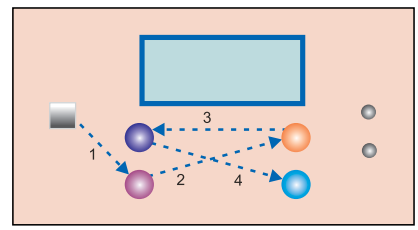


Fig. 8: Before change

Combining displays and inputs. Displays and their associated controls should be designed and located such that the user can select the correct control and operate it effectively, without errors.

Combining multiple displays. When multiple displays provide information to the user, he or she will invariably have to divide the attention between a number of tasks, as well as displays. Any inconsistencies in the manner of information representation among displays will be confusing. This will reduce the speed of reaction to change, indicated by displays. This can even cause reading or decision errors. If a number of displays look alike, the user may interpret data incorrectly. Each display should be easily distinguishable from, and its information should not be easily confused with, any other display.

Designing the keyboard and display together (UI)

Now that we have seen the design of input devices and displays separately, let us now see, when we design a system, how these two have to be put together in a balanced way. When a product is designed, there are three primary aspects that need to be addressed, which are:

Aesthetics. Deals with how the product looks

Ergonomics. Sees how easy it is to operate the product and that the product does not impact the user adversely

Engineering. Checks how easy it is to manufacture the product, without increasing the manufacturing cost

A UI is guided by the following three principles from an ergonomics perspective:

Operation sequence. Determines how the product is operated using keys (input) and displays (output)

Frequency of use. Checks how frequently the UI will be used

Centre of attention. Check which elements in the UI need higher attention

Let us see how a user can use this concept, with the following example. Refer to Fig. 8, where a front panel with a display, switch and knobs are shown, and where arrow marks show how the user uses the interface.

You can see how the key sequences go across the product face. This could have been due to the functional grouping of keys, knobs and displays. However, when the user will use this, he or she must remember the sequence of travels across the face of the product every time he or she uses the product.

Instead, if keys are arranged in the use sequence order shown in Fig. 9, the user can remember the sequence of use easily and use the product with ease. This effectively demonstrates how an ergonomic UI can be designed.

Next is the frequency of use. To help users use the product quickly and easily, following rules will help in designing an effective UI:

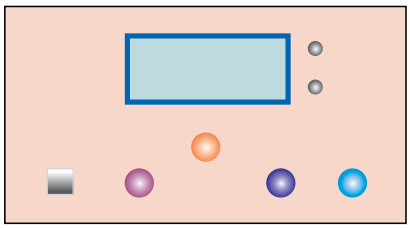


Fig. 9: After change

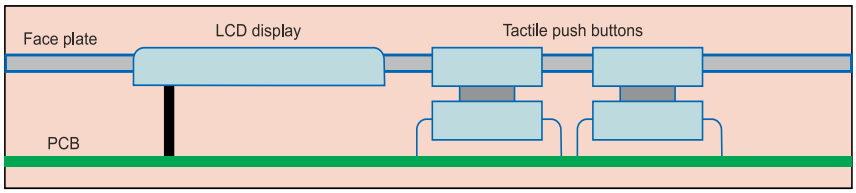


Fig. 10: Designing of a push button

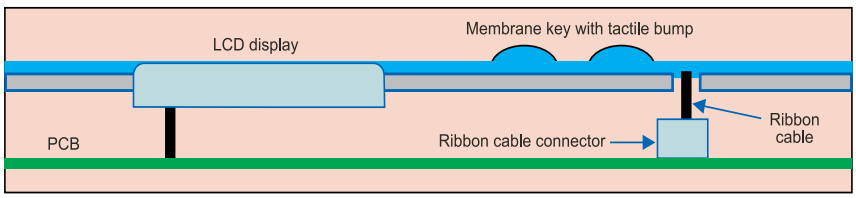


Fig. 11: Designing of a membrane key

1. Controls and displays associated with each other should be placed in a compatible way
2. There should be a very clear demarcation between visual display elements and controls
3. Horizontal hand movements are better than vertical
4. Movement of hands towards the body is better than away from it
5. Horizontal orientation of keys is often preferred
6. Square keys are preferable as compared to other shapes
7. The maximum number of keys in a row should not be more than four
8. Most frequently used buttons should be on the right side of the system

Finally, let us see the engineering aspect of the UI. This essentially ensures that the UID is easily manufacturable and does not need a complex assembly process. This is also important from the product-service point of view.

Figs 10 and 11, respectively, show how a push button and a membrane key, both LCD UIs, can be designed for ease in manufacture.

These two designs are representative designs as engineering depends on the components and the manufacturing process used. Higher the automation, more the precision needed for the design. ●

Pocket-Friendly Oscilloscopes Under ₹ 50,000

Abhishek A. Mutha is a senior technical correspondent at EFY

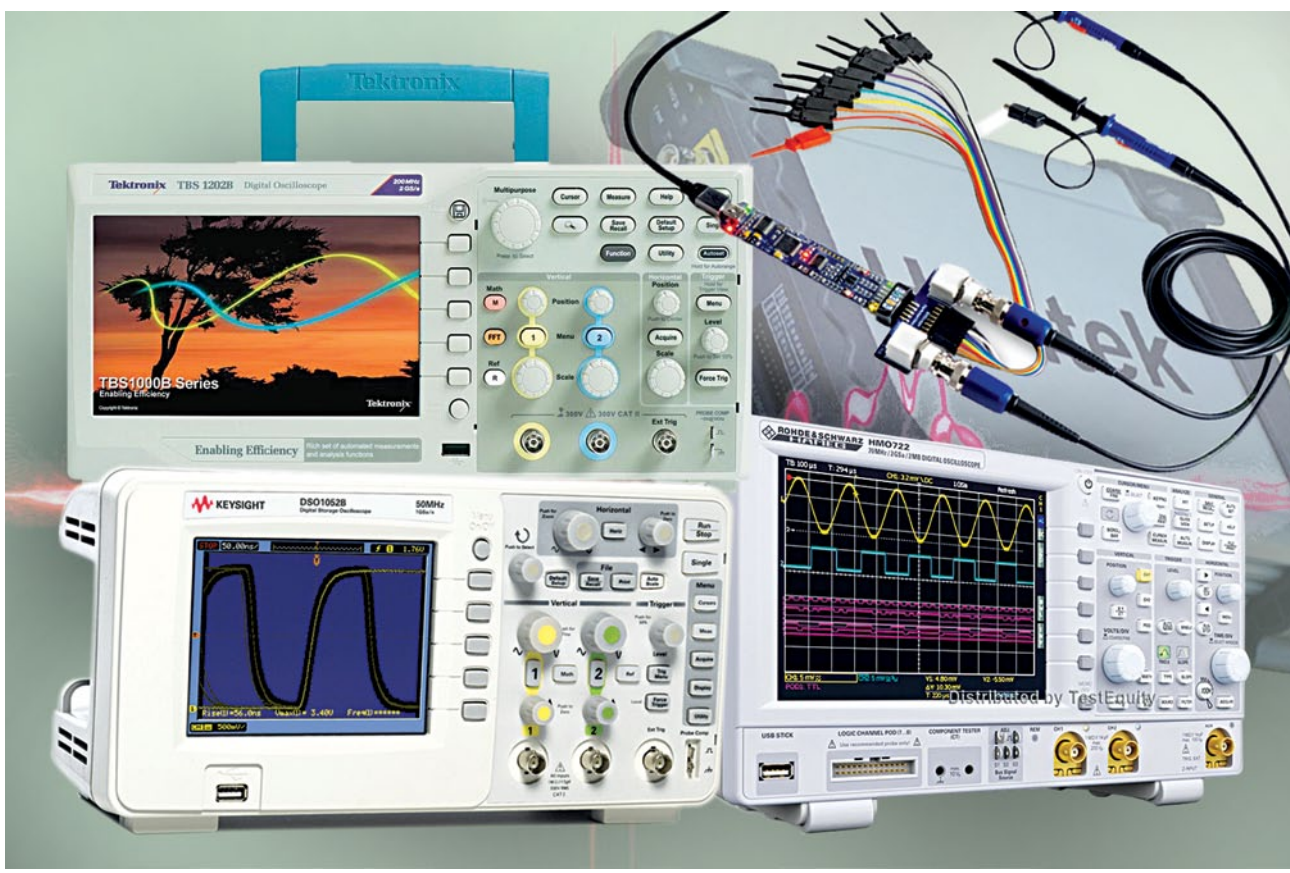
Do you feel your old oscilloscope has served you long enough; is it bulky, cumbersome and feature-starved? Or, are you planning to buy an entry-level, digital oscilloscope for your basic test and measurement (T&M) needs but cannot figure out which one to buy? Look no further. In this article, we attempt to help you find the best oscilloscope for your application from a wide range available in the market.

Being a widely-used T&M instrument, an oscilloscope is a useful tool for any engineer, maker or hacker. It comes in a variety of form factors.

There are hardly any exciting developments or introductions transpiring in the entry-level, benchtop oscilloscope segment. However, there are many interesting universal serial bus (USB), do-it-yourself (DIY) and pocket-sized oscilloscopes that have been released in the last couple of years. From benchtop to portable and miniature ones, let us take a look at the wide variety of digital oscilloscopes available out there, which are also pocket-friendly.

Benchtop scopes are reliable, provide solid performance

Many companies today are offering benchtop oscilloscopes targeted at engineers, hobbyists, do-it-yourselfers (DIYers) and



Some pocket-friendly oscilloscopes currently available in the market

TABLE I
Some Benchtop Oscilloscopes

Brand	Product	Channels	Bandwidth	Sampling rate	Memory depth	Display#	Warranty	Other notable features	Price
Rigol	DS1102E/ DS1052E	Two analogue	50MHz/ 100MHz	1GSa/s	1Mpts	14.5cm (5.7-inch) TFT	Three years	• Vertical sensitivity ranges between 2mV/div and 10V/div • Standard interfaces such as USB host and device, RS232, P/F out	₹ 21,080**/ ₹ 25,564**
Tektronix	TBS1052B	Two analogue	50MHz	1GSa/s	2.5kpts	17.8cm (7-inch) TFT	Five years	• 34 automated measurements • Dual-window FFT • Automated, extended data-logging feature • Auto-set and signal auto-ranging • Small footprint and lightweight • Only 124.5mm (4.9-inch) deep and 2kg	₹ 32,801*
Keysight	DSO1052B	Two	50MHz	Up to 1GSa/s	Up to 16kpts	14.5cm (5.7-inch) LCD	Three years	• 23 automatic measurements • Waveform math including FFT • Free education student lab guides and professor slide sets • Sequential acquisition of up to 1000 trigger events, go/no-go mask testing and selectable digital filters	₹ 34,696*
Tektronix	TBS1052 B-EDU	Two analogue	50MHz	1GSa/s	2.5kpts	17.8cm (7-inch) TFT	Five years	• Same as TBS1052B but comes with integrated courseware feature, which gives the ability to create lab descriptions and instructions and then upload the material directly onto a TBS1000B-EDU oscilloscope	₹ 37,911*
Tektronix	TBS1022	Two analogue	25MHz	500MSa/s	2.5kpts	14.5cm (5.7-inch) TFT	Five years	• 16 automated measurements • Automated, extended data-logging feature • Auto-set and signal auto-ranging • Small footprint and lightweight • Only 124.5mm (4.9-inch) deep and 2kg	₹ 39,555*
Rohde & Schwarz	HMO722/ HMO724	Two/four analogue	70MHz	Up to 2GSa/s	2Mpts	16.5cm (6.5-inch) TFT	Three years	• Mixed-signal oscilloscope with eight logic channels • Component tester, 6-digit counter, auto-measurement six parameters (maximum) • Trigger modes: Slope, video, pulsewidth, logic, delayed and event	N/A
Scientech Technologies	Scientech 401	One	50MHz	500MSa/s	32kpts	17.8cm (7-inch) TFT	One year	• Real-time sampling rate 500MSa/s, equivalent sampling rate 50GSa/s • Unique digital filter function and waveform recorder function • 32 parameters auto-measure function	N/A
Scientech Technologies	Scientech 402	One	70MHz	1GSa/s	2Mpts	17.8cm (7-inch) TFT	One year	• With a higher bandwidth, memory depth and sampling rate, other notable features are same as above	N/A

**Price listed as on e-commerce websites like element14.com and others*
 # Colour displays
*** Price converted from US$ to ₹ (1 US$ = ₹ 64). Landing price may vary slightly when bought from Indian distributors*

design houses, providing affordable performance on a tight budget. Although, these limit mobility and consume considerable amount of bench space, most oscilloscopes available under this category come with reliable features required for basic T&M needs such as USB connectivity for easily connecting to a laptop or personal computer and data storage purposes, signal auto ranging, numerous automated measurements, automated data logging, frequency counter, auto set with selective bandwidth models like 25MHz, 40MHz, 50MHz, 60MHz, 70MHz, 100MHz, 150MHz and 200MHz.

Considering a price point of ₹ 50,000 and below, majority of the general-purpose digital scopes offer bandwidths up to 70MHz with dual analogue channels. The sample rate for such oscilloscopes is usually between 1GSa/s and 2GSa/s. Higher bandwidth and four analogue channels for educational and industrial purposes exceed the ₹ 50,000 mark.

"An oscilloscope is an indispensable tool for any engineer who is working on design, test or even repair of any electronics equipment. It helps to visualise the functioning of an electronics circuit and can act as an engineer's eye to the electronics world. Therefore it is important to carefully choose the right oscilloscope, which would be required to capture the signal of interest" — Akash Srivastava, application engineer, Keysight Technologies India Pvt Ltd

Apart from technical features, a unique aspect that some oscilloscope makers are incorporating is assistance for students and professors. For instance, Keysight Technologies' DSO1000A/B series provides training tools such as education student lab guides and tutorials, and professor slide sets of oscilloscope fundamentals.

Tektronix's TBS1000B-EDU series come with an integrated courseware

TABLE II
Some USB/PC Based Oscilloscopes

Company	Product	Channels	Bandwidth	Sampling rate	Display memory depth	Price
Bitscope	Bitscope Micro (oscilloscope + logic analyser)	Two analogue, six digital	20MHz	40MSa/S	—	₹ 11,641*
Pico Technology	PICOSCOPE 2204A-D2	Two analogue	10MHz	100MSa/S	8kpts	₹ 15,312*
Pico Technology	PICOSCOPE 2205A-D2	Two analogue	25MHz	200MSa/S	16kpts	₹ 19,502*
Hantek	DSO3064	Four analogue	60MHz	200MSa/S	10kpts-16Mpts	₹ 27,490*
Tenma	72-10155	Two analogue	40MHz	100MSa/S	64kpts	₹ 29,936*
MEILHAUS	DS1M12	Two analogue	250kHz	20MSa/S	32kpts	₹ 39,933*

**Price listed as on e-commerce websites like element14.com and company websites*

TABLE III
Interesting Miniature, Pocket-Size Oscilloscopes

	Oscium's iMSO-204 and iMSO-204L (lightning-compatible) are mixed-signal oscilloscopes designed specifically for the iPhone, iPad and iPod. Highlights: Two analogue + four digital channels, sample rate: 50MSa/S, bandwidth: 5MHz, 200ns/div-10s/div Price: US$ 399.97
	Gabotronics' Xminilab Portable is a small mixed-signal oscilloscope with an arbitrary waveform generator and protocol sniffer. Highlights: Two analogue inputs, maximum sampling rate: 2MSa/S, analogue bandwidth: 200kHz, resolution: 8-bits, input impedance: 1MΩ 15pF, buffer size per channel: 256, input voltage range: -14V to +20V Price: US$ 118
	LabNation's SmartScope is a 100MSa/s open source oscilloscope for iPad, Android and PC. A must-have for every Arduino and Raspberry Pi developer. Highlights: 2x100MSa/s 45MHz oscilloscope, 50MSa/s arbitrary waveform generator digital-logic analyser at 100MSa/s, digital waveform generator at 100MSa/s, 200 waveforms/second data updates Price: US$ 229
	Gabotronics' oscilloscope watch Highlights: Two analogue inputs, maximum sampling rate: 4MSa/s, analogue bandwidth: 200kHz, resolution: 8-bits Price: US$ 150
	RedPitaya Highlights: DIY oscilloscope with dual channels with a sampling rate of 125MSa/s, spectrum analyser with 50MHz, 14-bit arbitrary waveform generator, frequency response analyser with 60MHz bandwidth and a 2x2 MIMO PID programmable controller Price: ₹ 46,750

**Price listed as on e-commerce websites like element14.com and company websites*

feature, which gives educators the power to share courseware materials between professors from the same institute or anywhere around the world. Professors can create lab descriptions and instructions, which can be made available on the oscilloscope.

These oscilloscopes are best-suited for research and development (R&D) applications, engineering measurements at educational institutions, and standard manufacturing and testing.

USB based and DIY oscilloscopes could be the right choice

Some industry experts are of the opinion that USB scopes have not yet reached the level of desktop models, but these are getting better with technological advancements in terms of measurement and reliability.

USB based scopes provide two important value additions to engineers—flexibility of converting a PC into a T&M platform and portability. In this era of the IoT, these scopes have a slightly greater edge over desktop versions. In fact, there are some interesting miniature devices that convert your laptops, tablets and mobile phones into a waveform analysing device at an affordable price. And, some of these are DIY type and open source, too.

Of course, not all USB scopes are as accurate as traditional oscilloscopes. For critical applications, USB devices would probably not be the right choice, but these are perfectly suited for educational institutions as well as hobbyists and engineers working on small- and mid-level applications on a tight budget.

With even major T&M companies (that are known for impeccable desktop oscilloscopes) continuing to add support to their range of USB oscilloscopes and introduce newer versions, it would not be wrong to predict that USB oscilloscopes in the future could completely replace desktop oscilloscopes in the basic oscilloscopes segment for general-purpose usage, provided these are reliable and sturdy like traditional box-type instruments in their measurements and analysis. You can take a look at some of the interesting devices in this arena listed in Tables II and III.

General Selection Criteria

Following specifications/features of an oscilloscope should be part of the selection criteria:

Bandwidth. Choose your bandwidth based on the edge speed (rise-time) of your signal. If you are unsure of your edge speed, you can use three times the clock rate for analogue signals or five times the clock rate for digital signals.

Application. Choose an oscilloscope according to the application like performing signal-integrity measurements or capturing intermittent signals.

Sample rate. For a Gaussian front-end, use four times the bandwidth. For a maximally flat (or brick wall) front-end, use 2.5 times the bandwidth.

Memory depth. Acquisition memory is the place where digitised samples are stored. Deeper memory allows you to keep your sample rate higher at slower time base settings, which allows you to maintain the full bandwidth longer. It is also useful when analysing waveforms particularly in single-shot mode. Look for a digital oscilloscope that remains responsive, even when deep memory is used.

Waveform update rate. When digital oscilloscopes are processing data, these cannot capture and display signals. Processing time is known as dead time. The shorter the dead time, the more likely you are to find infrequent events. In order to capture an infrequent signal, check if the digital oscilloscope slows down when you use features like digital channels, serial decode or more than the default memory. For debugging and troubleshooting, the higher the update rate, the better the oscilloscope.

Number of channels. The oscilloscope generally has an option to choose between two or four analogue channels and, additionally, have digital channels.

Probes. The oscilloscope probe is an integral part of the measurement system. These are classified as passive and active probes. Select an oscilloscope that provides connectivity to passive as well as active probes.

—Akash Srivastava, application engineer, Keysight Technologies India Pvt Ltd

> **"For general-purpose measurement, prices of oscilloscopes vary from ₹ 12,000 to over ₹ 150,000. Therefore buyers need to be clear on their requirements for use, budget and expected lifetime of its use, while not forgetting the warranty that comes with it"** — Abhishek Rao, technical marketing manager, element14 India

Choose wisely

Between benchtop, USB and DIY, it could be a daunting task to choose the right oscilloscope for your needs. We have featured some of the hundreds of varying models with widely differing costs and specifications. It is important to invest some time considering the use case and application area of your potential oscilloscope. It would be wise to follow the try-before-you-buy policy, read reviews and ask the T&M vendor to provide a demonstration.

Warranty is also an important factor to pay heed to. Tektronix provides a five-year warranty on their benchtop scopes, whereas other reputed companies such as Rigol, Keysight and Rohde & Schwarz offer three-year warranty on their range of desktop scopes. USB and DIY scopes typically come with a one-year warranty. Features such as bandwidth, sampling rate and memory depth are not upgradable in most of the oscilloscopes in the market. ●

STAR: A Multi-Purpose Wearable Gadget from India

Anagha P. is a technical correspondent at EFY

Wearable technology has seen tremendous growth in the past year. A recent report on wearable electronics market by *Business Insider* forecasts that the global wearable devices market will grow at a compound annual rate of 35 per cent over the next five years, reaching 148 million units shipped annually in 2019. Competing with global players in this arena, we now have a wearable band designed and manufactured completely in India.

Founded in 2013, Belgaum based SenseGiz Inc. has come up with STAR, an affordable multi-purpose smartdevice that can be clipped to clothing or worn as a band. This tiny device can track the user's fitness and sleep quality, provide idle alerts, display time, deliver calls, texts or mobile app notifications, control smartphone functions with simple gestures, trigger automatic alarm on loved ones' phone numbers if they suffer a fall or crash, and has a panic button to get help in an emergency.

Innovative functionalities

STAR was developed with the idea of getting timely help in case of emergencies. Instead of the user taking out the phone and making a call for help, this device automatically triggers an alarm to the user-defined phone numbers. Also, the user does not have to take out the phone every time a call, text or app notification comes up; it can be viewed on the screen of this device.

STAR can also function as a pedometer and a sleep tracker. It motivates the user to be more active in the day with idle alerts and fitness goal reminders. It tracks physical activities in terms of number of steps taken, distance covered and calories burnt. It also measures sleep quality in terms of light sleep versus deep sleep and interruptions.

Another interesting feature of this device is that, you can define hand gestures (for example, claps, taps or rotation of hands) to perform different operations on your smartphone such as making a call, clicking a photo, playing a song or launching an app.

SenseGiz STAR

What powers the device

The entire circuitry of STAR is enclosed in a polycarbonate casing with a small factor of 40mm (l) x 22mm (w) x 11.5mm (h). It is splash-resistant, though not waterproof, which means it can withstand sweat, splashes and rain. An organic light emitting diode (OLED) display unit serves as the user interface (UI), and the device operates at a temperature range of -20°C to +60°C.

Power source. Power to the device is provided by a rechargeable 3.7V, 150mAh lithium-ion polymer (LiP/LiPo/li-poly) battery. When fully charged, the battery lasts for a week even with constant usage. It takes just 90 minutes to charge the device from zero to 100 per cent with the standard micro-USB B charger cable that comes with the product.

Communication. STAR uses Bluetooth Smart, also known as Bluetooth 4.0 and Bluetooth Low Energy (BLE), module to connect and sync with the phone app.

Sensors and processor. The device houses multiple accelerometers capable of detecting up to 200g force span and a 3-axis gyroscope. The heart of the device is a high-performance microcontroller (MCU) that processes data from sensors to obtain required results.

Smartphone-enabled functions

SenseGiz STAR is supported by a free app for Android and iOS devices. The user's fitness data in terms of number of steps taken, amount of calories burnt and total distance covered, and sleep quality in terms of light sleep, deep sleep, total sleep and interruptions can be viewed on the app. Other features like user-defined gesture control, setting alert notifications for crashes/falls and defining emergency contacts can also be performed using this app. STAR regularly, and automatically, synchronises with the phone app via BLE and even displays call, text and app notifications on its OLED screen.

Hurdles in syncing with app and cloud

To ensure the feature that displays time on the screen like a digital watch or clock works up to the mark, developers needed to ensure that this time display is synchronised with Greenwich Mean Time (GMT) and the local time zone through phone synchronisation.

On the cloud side, the user needs to ensure a regular synchronisation mechanism of the gadget with the mobile app. But at the same time, all calculations on the app side need to be performed within one or two seconds, so that information and guidance can be communicated to the user in real-time.

The issue was approached by using a lean-sync mechanism with the cloud at regular intervals. The team minimised the usage of the central processing unit (CPU) of the smartphone by the app for all calculations, thereby avoiding battery wastage.

Specifications

Device	:	STAR
Brand	:	SenseGiz
Founders	:	Abhishek Latthe, CEO, and Apurva Shetty, COO
Models	:	Two designs: clip-on and wristband Four colours: classy black, flawless white, bubbly blue and perky pink
Pricing	:	₹ 6000
Website	:	*www.sensegiz.com/star*
Contact	:	info@sensegiz.com

Challenging algorithm

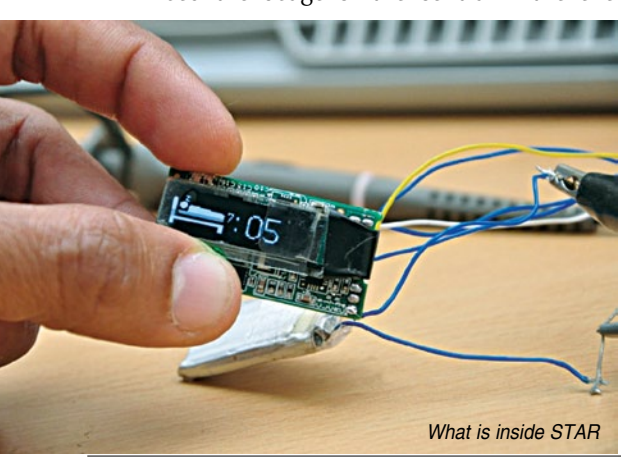
The major challenge faced by the team while designing the product was to eliminate any kind of false crash alarms that would negatively affect the product functionality and reliability.

Another challenge was to differentiate between deep sleep and light sleep as the device is supposed to work as a sleep-quality tracker.

The next goal was to precisely count the number of steps taken by the user during a walk. Also, the device is supposed to accurately interpret hand gestures to perform different operations associated with it by the user.

The fall/crash-detection algorithm takes into account what is happening before, during and after a fall/crash event has taken place. For example, forces associated with high-impact and rapid body movements during a fall and movements of the user after the event are monitored to make a decision on the event.

After several iterations, the team was finally able to come up with well-built algorithms that can distinguish between a fall and a crash, would not report any false crash alarms, monitor the type and duration of sleep, count the number of steps covered and interpret hand gestures in an effective manner. SenseGiz has also applied patent for the fall/crash algorithm, which they have developed.



What is inside STAR

How is STAR different

There are several fitness bands of varying functionalities and prices available in the market these days. Why choose STAR over other products? The team explains, "Safety is the main feature we focus on and this is what differentiates our product from our competitors."

The device automatically detects falls and crashes, even the severity of these, and an alarm in the preset phone number(s) automatically goes off in case of an emergency. This alarm is more likely to get noticed by another person rather than a simple text message (SMS, in most cases) featured by some gadgets.

STAR also has a panic button that can be pressed when physical danger is anticipated or the user needs immediate help. The logic behind this is that, pressing this panic button is easier than searching for the phone and calling someone, especially when time is a critical factor.

Now, the design challenge arises; what if the panic button is pressed by mistake? In order to activate a panic alert, this button should be quickly pressed twice, so chances of false alerts are less. Also, there is a user-defined countdown timer on the app that can disable sending of alerts if there is no emergency.

Multiple features like safety, fitness and UI screen displaying notifications come together at a competitive price and no other wearable device offers all these features in a single product.

From idea to market

The development of STAR from idea into a fully-functional product took approximately one year, says the SenseGiz team. The clip version of the device is already being sold directly to customers or through retailers in more than ten countries across the globe. ●

Manage those fans in a better way and easily cut down power consumption

Power and automation are two areas that stand to see significant gains from modern sensor, processing and communication technologies. Vivek Sharma, regional vice president, Greater China and South Asia region - India operations, director - India design centres, STMicroelectronics, speaks with Dilin Anand of EFY

VIVEK SHARMA
REGIONAL VICE PRESIDENT, GREATER CHINA AND SOUTH ASIA REGION - INDIA OPERATIONS, DIRECTOR - INDIA DESIGN CENTRES, STMICROELECTRONICS

Q. What aspect of power the engineers should know?

A. Smartpower is a very important aspect. Power generation has both conventional and non-conventional aspects. Many electronics are going into non-conventional areas. Solar, for example, is a solution that ensures there is no reduction in power consumption even if a part of the panel comes under shade. When you look at power inverters, it is a need specific to our country and not something seen on the international stage.

Power-line communications is another technology that works in the international arena but not in India. When it comes to transmission of power in India, we end up using power even when we are transmitting.

Pilferage is one aspect; non-efficient way of transmission is another that lets you optimise these areas. Power-line communications and smartmetering can help identify where the leakages are happening.

Q. What are some ways to reduce power consumption?

A. Motor control is an important area here. Motors worldwide consume more than 55 per cent of power. If we can just have a better, more efficient way of controlling motors, like in a fan, we could save a a lot of power.

We have millions of fans being used every year. If we had those fans with more electronics, call it electronic fans, we could manage those fans in a better way and easily cut down power consumption by 40 per cent. This can be done by utilising the latest sensor, microcontroller and communication technologies.

Q. What makes sensor technology so important?

A. A sensor like an accelerometer is not something new. But, it has been miniaturised and the volume of production has made it so cost-effective that you can put it almost anywhere, including toys, wearables and even vehicles.

Q. How has electronics helped improve vehicular safety?

A. Proactive safety is where we try to prevent the event from happening, and electronics plays an important role here. Radar systems or driver-assist systems are examples where drivers are warned according to the data collected by electronics systems if something somewhere has a chance of going wrong. What happens is that, the system alerts the driver, hence preventing the accident.

We also have anti-skid features where the system detects a skid and implements measures to stop the vehicle from skidding, thus preventing accidents.

Q. Automotive infotainment seems to be a very exciting segment too; what is happening there?

A. Automotive infotainment has migrated from what used to be a CD player to something that provides navigation in your car, like a GPS, and connected cars.

You no longer just monitor car conditions but also transmit these online. This means, if you have given your car to a friend, you can see what is happening apart from where the car is. You can also see how the driver is driving. This is very helpful for people who are running fleets of buses or trucks. Fuel consumption could also be monitored and optimised through this. So, connected vehicles are expected to be very important.

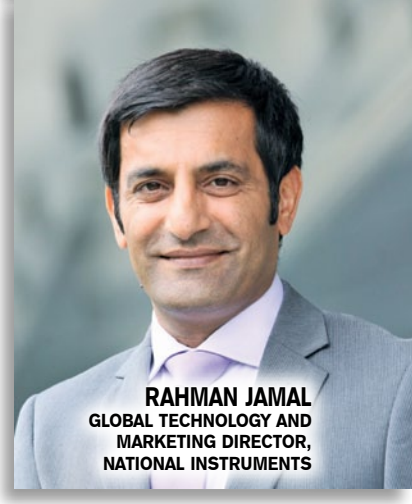
Q. What is exciting thing about industrial Internet?

A. Industrial Internet is a beautiful thing. An industrial cycle is like a supply chain; you can let these devices communicate among themselves, thus reducing the burden on humans. It can help enable parts requirement and production management to be done by computers, thus speeding up the process and enabling humans to focus on more intellectual challenges. For instance, if a machine's health is deteriorating, you can have the machine communicate to you when its health hits a pre-set low, and it will let you know exactly when to interfere.

Q. How is automation we previously had different from what we have now?

A. Let us take an example of an air-conditioner at home. When it is running, the thermostat is communicating with the air-compressor. It checks the room temperature and when the temperature goes down a particular limit, it stops the compressor. This was previously happening within the machine, but now the Internet flattens everything and allows all machines to come on to the same platform.

"Processors will have more processing power than the human brain"



RAHMAN JAMAL
GLOBAL TECHNOLOGY AND MARKETING DIRECTOR, NATIONAL INSTRUMENTS

5G has not been formally defined yet, but it has become imperative to connect machines and people to each other across the planet. However, will it be just another increase to the peak bandwidth? Rahman Jamal, global technology and marketing director at National Instruments, explains as he speaks with Dilin Anand from EFY

Q. From the technological perspective, what is driving the Internet of Things (IoT)?

A. There are multiple technologies driving this trend. There are laws that make these things affordable, such as Moore's Law that states that the number of transistors per unit area on integrated circuits doubles every 18 to 24 months. Other driving elements are Metcalfe's Law, Neilsen's Law, an increasing number of systems from wired to wireless and, finally, sensors that are the sense organs of the IoT.

Q. How are these laws and technologies driving the IoT?

A. Moore's Law has guided us over the past few decades as we have made processors smaller, faster and more affordable, putting a sea of transistors on a tiny chip. In the coming decades, technologists estimate that processors will have more power than the human brain.

Metcalfe's Law has shown us that every time we add a node to a network, the value increases by a factor of two, encouraging us to connect everything and synthesise data.

Nielsen's Law is about the bandwidth of the data highway, namely, the Internet, and states that a high-end user's connection speed grows by 50 per cent every year.

The battery technology needs to improve continually with new compounds and enabled electronics to become detached from the grid for longer amounts of time.

With sensors, the more sensing you add to things that are connected, the more context-aware these become. Combined with data analytics, these can give more valuable information.

Q. How important will the 5G telecommunications networks be to the success of the IoT?

A. Though today's 4G networks continue to offer faster data access, the road beyond LTE and LTE-A is far from clear.

5G networks must accommodate many more users and devices while delivering more data to each user at any instant. Researchers envision not only a 5G network with unprecedented data rates and mobile access but also an opportunity to redefine the network to accommodate a wealth of new and diverse connected devices.

5G targets peak data rates per user in the range of 10Gbps (over 1000 times 4G). To provide a frame of reference, a user can download an HD video in seconds with 5G, while it took about 40 minutes to download the same video using the highest speed networks in good conditions.

Q. What kind of 5G research is happening right now?

A. There are many universities and research institutes that are looking at different aspects of 5G. For instance, the 5G wireless lab in Germany, Technische Universität Dresden, led by Dr Gerhard Fettweis, is looking at 5G from the waveform perspective and designing orthogonal frequency division multiplexing (OFDM) prototyping systems based on NI's RF and communication tools.

At New York University, Dr Theodore S. Rappaport is looking into millimetre waves around 28GHz, 38GHz and the 71GHz to 76GHz range.

Then, Nokia Networks has prototyped a mmWave communication link and is achieving data rates 100 times above current 4G rates with deterministic latency. By using NI's integrated hardware and software baseband platform, Nokia plans to demonstrate the viability of high-frequency millimetre wave as an option for 5G radio access technology.

Q. How is technology taking this to the next level?

A. Let us take an example from India. The traffic here seems to regulate itself. There are lanes but no one follows these. Roads keep changing from one-lane to multiple-lanes, and back. This happens because there is this collective intelligence of the people operating the vehicles.

In contrast, in the west, we find a more centrally-controlled traffic system. There is no flexibility because the lanes are of fixed size and the whole bandwidth is not used all the time; you might find one side of a four-lane highway completely empty, while the other side is jammed. In India, the whole bandwidth gets regulated.

Q. Will the next generation of connected cars need 5G?

A. When cars begin communicating with each other, these would not just be sending single data; these would also send waveform data, which requires a different bandwidth when these cars really need to talk to each other, and 5G will hopefully meet these needs.

This Month's DVD Contents

This month's DVD contains some interesting software starting from LabVIEW and Ngspice in the electronics design section to a circuit design tool for printed circuit boards (PCBs). It also contains utility tools supporting electronics design and simulation processes

SNEHA AMBASTHA

LabVIEW

LabVIEW is a system design software that provides comprehensive tools to build any control or measurement application in minimum time. It helps in accelerating productivity, solving problems and continuing innovations with accelerated results. It also allows the user to save, present and share the results of measurements for future use. This student version of the software has limited features; however, other full versions are also available from National Instruments (NI).

LTspice IV

This free Spice simulator with high-performance simulation technology from Linear Technologies comes with a schematic capture, waveform viewer with models and enhancements to make the simulation procedure of switching regulators easy and extremely fast.

Ngspice

Ngspice is an open source Spice circuit simulator with its code based on three open source software packages, namely, Cider1b1, Xspice and Spice3f5. This general-purpose mixed-signal or mixed-level simulation tool works for both linear and non-linear circuit analysis, that is, it can work with circuits containing both active and passive components.

VeroDes

VeroDes is a circuit design software for Veroboard or Stripboard. Converting schematics with copper tracks on Veroboard is quite difficult because these are fixed. VeroDes makes it easy to do so. It works on Linux platform and allows the user to print layouts so designed on both sides of the board. It helps cut out tracks and place components at the required places, eliminating the effort required for scribbling diagrams on graph paper.

SAEAUT SCADA

SAEAUT SCADA version 5.03.0.3 is a supervisory control and data acquisition (SCADA) software that allows the user to monitor, control and store data, and process the alarm. It makes communication with various devices easy and enables database communication through dynamic data exchange (DDE) servers and open platform communications (OPC).

Advanced Trigonometry Calculator

Advanced Trigonometry Calculator version 1.8.0 is a software solution that provides a reliable means for performing mathematical calculations with less effort and with a high level of precision. It is freely available and can be used on Windows operating system (OS). It only works with CMD interface and thus requires basic knowledge of the CMD interface.

ZCad

ZCad version 0.9.8 helps create complex computer aided design (CAD) projects. Its console already contains some examples and input commands for assistance. It is a free program that runs on Windows OS.

Capture Argo

Capture Argo version 21.0.12 is a lighting application for professionals. It helps create complex lighting systems for theatres and concerts. It creates a user-friendly working environment and allows technicians to use their knowledge and skill to create a lighting system for stage shows. It requires the knowledge of light physics and human perception for creating modern lighting systems.

CImg

CImg is an open source library and a modern C++ toolkit for image processing. It allows the user to manage images using C++ codes. It can not only load or save image file formats but also access pixel values and draw primitive images. It is a highly portable and lightweight software and is thread-safe. It is compatible with compilers like Visual C++, g++ and clang++.

TarsosDSP

Being a Java library for audio processing, TarsosDSP aims to provide an interface for the implementation of music algorithms in pure Java without external dependencies. The Java library demonstrates the working of the digital-signal processing (DSP) algorithm. It has a number of pitch-detection algorithms and a percussion-onset detector.

Popular resources

- 7Zip. Version v.9.38 (file archiver)
- Java Development Kit (JDK). Version 8.0.450.15 (development kit to create Java runtime environment for various applications)
- VLC. Version 2.2.1 (media player)
- Opera. Version 29.0.1795.60 (Web browser)
- Free Download Manager. Version 3.9.5 (file download manager)
- Thunderbird. Version 31.1.0 (email application)
- Mozilla Firefox. Version 38.0.1 (Web browser)
- Apache Open Office. Version 4.1.1 (open office)
- Ubuntu. Version 15.04 (operating system)

The author is a technical correspondent at EFY

TarsosDSP: A Real-Time Audio Analysis and Processing Framework

JAI SACHITH PAUL

In last month's EFY Plus, we discussed Essentia, a C++ library for audio analysis. In this issue we will discuss a Java based real-time audio analysis and processing framework known as TarsosDSP.

The tool is counted as one among the few frameworks in Java ecosystem that provides both real-time feature extraction as well as synthesis. The framework consists of easily-extendable practical audio-processing algorithms. Owing to the educational goal of music information retrieval (MIR), these algorithms are made as simple and self-contained as possible using a straightforward pipeline.

Whether you are a student trying to understand the concepts of MIR or an experienced researcher working on music analysis, TarsosDSP is the ideal choice for you. The real-time feature extraction and synthesis capabilities make this software an ideal candidate for music education tools and music video games. Try out the latest release of the software version 2.2 that comes with this month's DVD for EFY Plus.

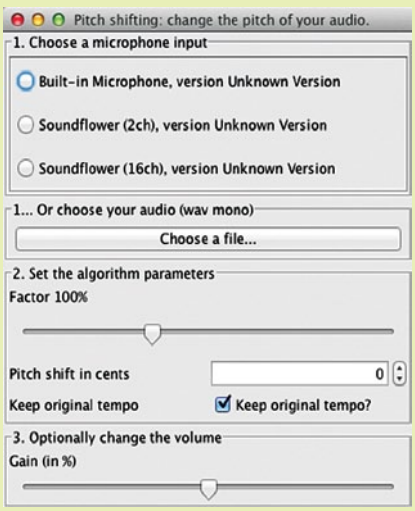


Fig. 1: Pitch Shifting, an application of TarsosDSP as an example

Framework overview

Name: TarsosDSP
Latest release: Version 2.2
Functionality: Real-time audio analysis and synthesis in Java
Licence: GNU general-public licence (GPL) version 3
For more information: *github.com/JorenSix/TarsosDSP*

Implementation in Java ecosystem

The framework, written in Java ecosystem, allows clean implementation of audio-processing algorithms. Compared to the ones written in C++, this Java based framework ensures better portability between various platforms.

The automatic memory-management facilities are yet another advantage implementing the framework in Java. The Dalvik Java runtime allows running the algorithms unmodified on Android platform.

With the exception of the standard Java runtime, there are no other external dependencies. For real-time applications, the operating environment is optimised to provide a low-latency audio pipeline.

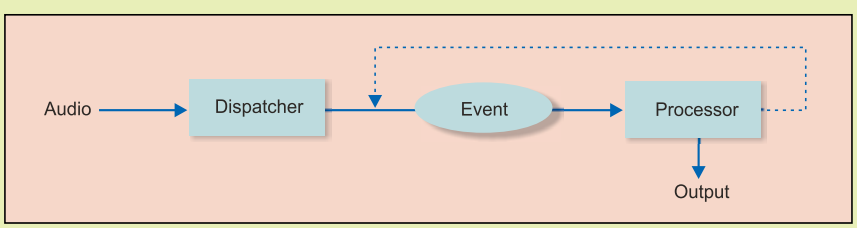


Fig. 2: TarsosDSP processing pipeline, a schematic representation

Simple processing pipeline

Another notable feature of this framework is its extremely simple processing pipeline. Limiting the input to a single-channel input makes the processing chain very straightforward. A multichannel audio input is automatically down-mixed to a single channel before it is taken to the processing pipeline.

Input samples are chopped and arranged into samples in blocks of variable sizes having a defined overlap, with the help of AudioDispatcher. The blocks are then wrapped and encapsulated in an AudioEvent object having a pointer for timing and some auxiliary methods for computing the energy of the blocks.

AudioEvent is passed through a series of AudioProcessor objects by AudioDispatcher. The core of the algorithms such as pitch estimation or onset detection is carried out in AudioProcessor.

TarsosDSP and competing tools

There are a handful of tools available in the market that work on audio signals.

Essentia software is an open source C++ library that allows us to have real-time music analysis. CLAM tool allows us to have real-time mu-

SINGmaster: An Android app that uses TarsosDSP

From version 2.0 onwards, the framework is Android-compactable. SINGmaster is the first Android application developed using TarsosDSP. This smartphone application helps a user to learn how to sing. There are practical exercises based on the important building blocks of melodies. The application makes use of pitch-tracking capabilities of TarsosDSP to give visual feedback, which allows the user to learn from mistakes.

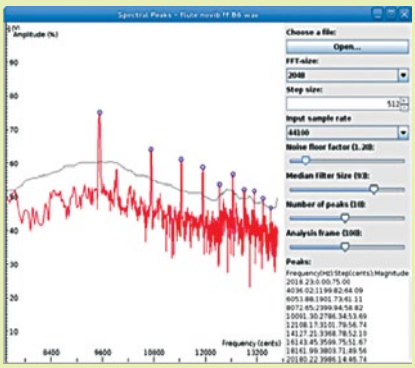


Fig. 3: Visualisation of spectral peaks of a flute

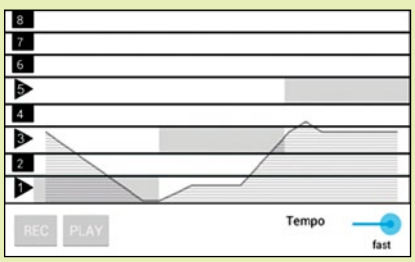


Fig. 4: Screenshot of SINGmaster application

sic analysis as well as synthesis, and is based on C language.

Create Signal Library (Sizzle) and SndObj are more C++ based projects that allow users to have both audio analysis and synthesis in real-time.

Beads, JASS, JSyn and Minim are Java based projects that allow users to have real-time audio synthesis.

TarsosDSP is introduced as a single framework that could cater real-time music analysis and synthesis needs in Java—something that no other competing tools provide—as per the research conducted by the developers of the tool.

Although algorithms used in software like jAudio and YAAFE are more efficient due to the reuse of calculations for feature extraction, these are less readable compared to TarsosDSP.

Highly-optimised libraries such as SoundTouch are again less beneficial for beginners on account of low readability.

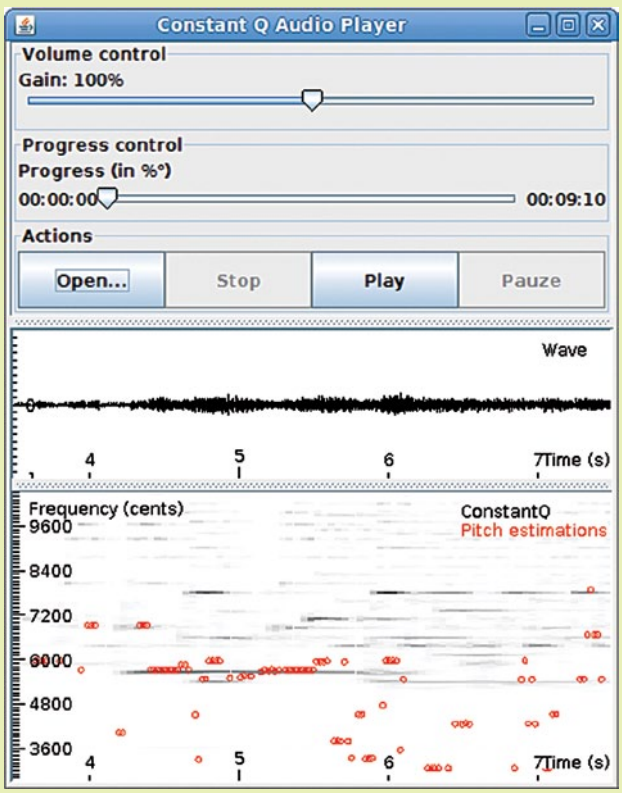


Fig. 5: Constant-Q transformation with an overlay of pitch estimations and corresponding waveform

Main features implemented

The tool was originally devised as a library for pitch estimation. Therefore you will find several pitch-estimating algorithms in this framework including YIN, McLeod Pitch Method (MPM), Average Magnitude Difference Function (AMDF) and an estimator based on dynamic wavelets.

There is a time-stretch algorithm using which the user can alter the speed of audio without changing the pitch.

Alternatively, we also have a pitch-shifting algorithm that allows the user to change the pitch without changing the speed. A resampling algorithm with related software package is also included.

TarsosDSP consists of two onset detectors and several infinite impulse response (IIR) filters including low-pass, high-pass and band-pass filters. Audio effects like delay and flanger effect are also provided. In a flanger, two copies of the same signal are mixed, with one of these slightly delayed for not more than 20 milliseconds to produce a swirling effect.

Another important functionality of the tool is audio synthesis. We can find sine-wave and noise generator in the tool. A low-frequency oscillator is also incorporated for amplitude control. Spectrum-estimating algorithms based on fast Fourier transforms and other techniques are also available.

Lossy audio compression using Haar Wavelet Transform

Haar Wavelet Transform (HWT) is widely used in various image- and signal-processing applications. It could be effectively used in signal compression or for edge detection in images. Let us take a look at one such use case of HWT algorithm implemented in TarsosDSP.

HWT used for a simple Lossy audio compression consists of the following steps:

First, it compresses the audio by dividing it into blocks of 32 samples. These are then transformed using HWT, and samples with the least difference between these are

subsequently removed. The inverse of the transform is found and audio is played. The amount of compressed samples could range from zero (no compression) to 31 (no signal left). This technique can effectively save at least one-tenth of the samples without any noticeable change.

Spectral-peak extraction module

The audio-processing library has a dedicated module for determining spectral peaks. The module computes a short-time Fourier transform (STFT) followed by the determination of the frequency bins having higher energy levels with the help of a median filter. Inclusion of phase information into the processing significantly improves the frequency estimation.

Spectral information and peak locations along with the noise floor computed with the help of the median filter are returned for each fast Fourier transform (FFT) frame. In Fig. 3, we can see the spectral peaks of a flute. Here, the peaks are spread over the entire spectrum harmonically, till its Nyquist frequency.


Joren Six

"TarsosDSP is an ideal DSP package for people who want to learn something about audio-analysis algorithms and experiment with audio processing. The library tries to hit the sweet spot between being capable enough to get real tasks done, and is compact and simple enough to serve as a demonstration on how DSP algorithms work."

—Joren Six, main developer of the software

Constant-Q transformation for music-processing applications

The function of Constant-Q transform is same as that of an FFT. But this transformation is much suitable for the applications involving the processing of music. The reason is that, each octave has the same amount of bins in case of Constant-Q transformation. A selection of 12 bins per octave can correspond with the western style of music. Fig. 5 shows Constant-Q transformation with an overlay of pitch estimations.

Catering to the academia

Owing to the needs of academics, preference is given to the readability of the code rather than the speed of executions. Algorithms are kept as pure as possible without obscure optimisations. The main intention is to meet the needs of people who are new to music analysis and synthesis. Those who are in the industry can optimise the codes in Java itself or in other alternatives like C++, as per their requirements. ●

The author is an electronics enthusiast from Kerala

Ngspice: Spice Circuit Simulator

SNEHA AMBASTHA

Ngspice is an open source Spice circuit simulator with its code based on three open source software packages, namely, Cider1b1, Xspice and Spice3f5. This general-purpose mixed-signal or mixed-level simulation tool works for both linear and non-linear circuit analysis; it can work with circuits containing both active and passive components.

Successor to Spice, Cider and Xpice

Although Spice3 is the most popular circuit simulator, Cider provides better simulation accuracy and Xspice extends the code-modelling support, Ngspice is considered to be the successor to all three.

Generally, circuit simulators are quite complex, and introducing improvements in such software is a tough task. However, Ngspice (the project) tries to bring these improvements by fixing bugs, refactoring codes and creating new features in Ngspice (the software), making it the improved version of Spice3f5.

Ngspice and Xspice

Xspice supports Ngspice in many ways. Xspice codes integrated into Ngspice help it to support both mixed-signal and board-level simulation. You may ask: How? The answer to this is very simple. Xspice codes in Ngspice allow it to inherit Xspice framework, which is a mixed-mode simulator that supports analogue as well as digital algorithms for circuit simulation. This ability also makes Ngspice a native mode simulator with an ability to provide two types of simulation in the same executable.

Additionally, Xspice integrates C language code models into Ngspice,

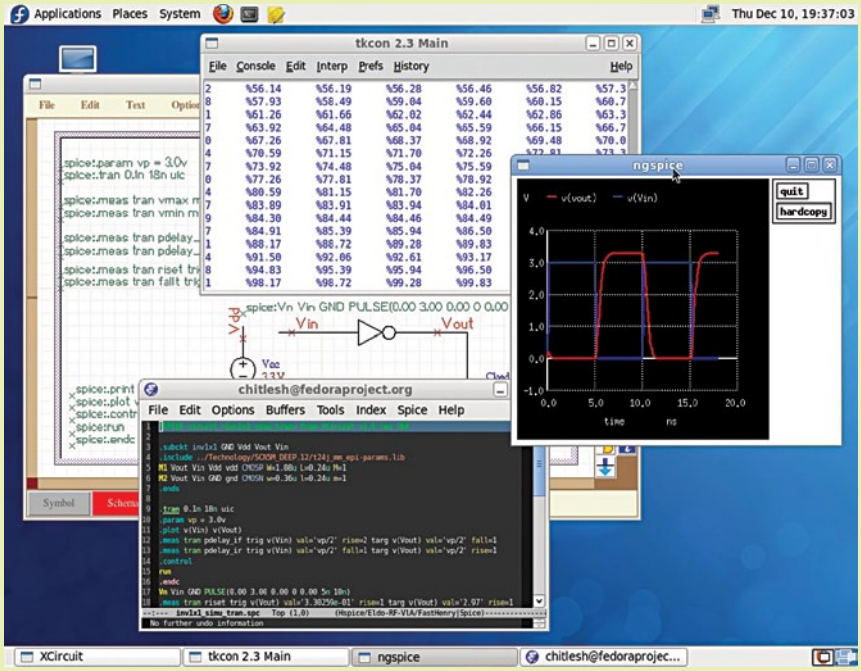


Fig. 1: Ngspice working on Fedora

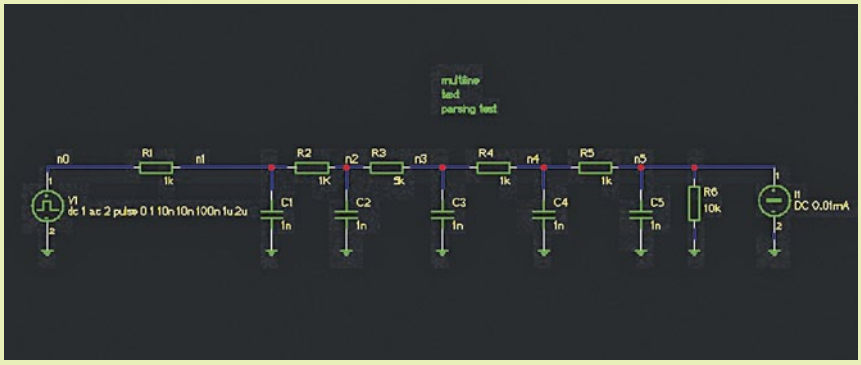


Fig. 2: Ngspice netlist

Competitive tools

➤ Hspice ➤ PSpice ➤ Spectra

which supports behavioural modelling by various devices like oscillators, filters and amplifiers.

Features

Developed by Paolo Nenzi and his team, Ngspice comes with many features that enable us to consider it

Overview

Version: 26plus (Ngspice rework)

Licence: Berkeley Software Distribution (BSD) licence

Operating system: LINUX, MS Windows, MAC, BSD, Solaris, etc

Key features:

1. Supports multiple circuit analysis
2. Can be compiled as a shared library, offering full simulator control over a calling process

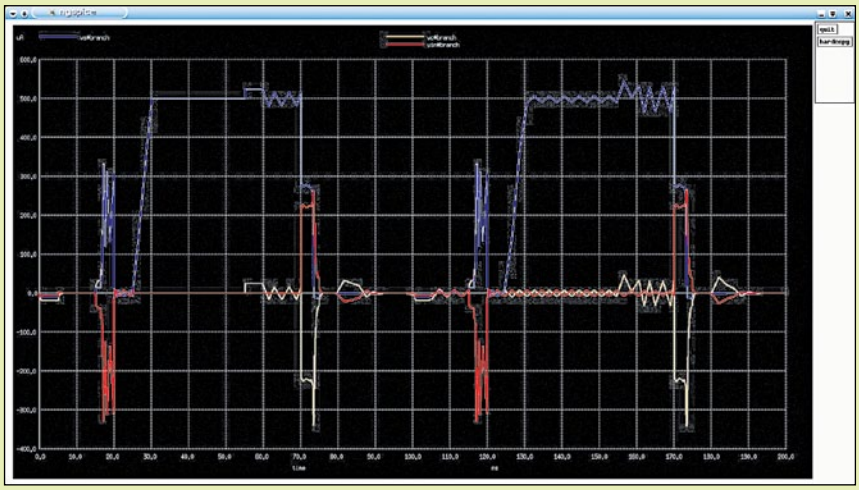


Fig. 3: Ngspice simulation output

How to use Ngspice

1. Using MS Explorer window (interactive mode):
   - ➤ Double-click on ngspice.exe in C:\Spice\bin
   - ➤ In the Ngspice window, type the following:
     - cd c:\spice\tests\bsim4
     - source comprt.cir
     - run
     - display
     - plot v(1) v(2) v(3) v(8) v(9)
     - write comprt2.raw
     - quit
2. Using MSYS window (interactive mode):
   - ➤ Open an MSYS window
   - ➤ In the MSYS window, type the following codes:
     - export PATH=$PATH:/c/Spice/bin
     - cd /c/Spice/tests/bsim4
     - ngspice comprt.cir
   - ➤ Ngspice window will open up; in that window, type:
     - run
     - display
     - plot all
   - ➤ Write the data into a raw file to the actual directory /c/Spice/tests/bsim4 using the following command:
     - write comprt.raw
     - and then type "quit"

Note. MSYS is specific about the file name and directory. Also, you should have administrator rights to the directory you are running these files from.

3. If the circuit file your are using is in a different directory (for example, C:\test\comprt.cir) than the interactive mode, then the following codes can be used to call Ngspice:
   - ➤ ngspice C:\\test\\comprt.cir or
   - ➤ ngspice C:\\test/comprt.cir

over other circuit simulators.

Built-in models. For every semiconductor device, Ngspice has a built-in model that only requires a few specifications to be set. In case of bipolar junction transistor (BJT), Ngspice has three built-in models, all of which are based on the integral charge model of Gummel and Poon; BJT reduces it to Ebers-Moll model, which is the simplest one.

Event-driven simulation. User-defined nodes allow event-driven simulation, where users are allowed to specify the nodes for data propagation of values other than current, voltage and digital states. However, state values in these cases might be an arbitrary data type. Ngspice implements these user-defined nodes in such a way that the data structure defines only the digital state held by a strength value and a Boolean logic state.

Supports multiple analyses. Ngspice supports multiple analyses like AC/DC analysis, transient analysis, pole-zero analysis, small-signal-distortion analysis, sensitivity analysis and noise analysis, where most of these are exclusively used by analogue

applications. The DC operating point in a circuit with capacitors opened and inductors shorted is determined by Ngspice, which then specifies the analysis options on .OP, .DC and .TF control lines.

Similar to this analysis, Ngspice carries out the AC analysis for small signals, where the steady-state behaviour of the described system is determined at the specified set of stimulus frequencies with a single input node.

The transient analysis option of Ngspice is basically an extension of the time domain in DC analysis so it accepts the results of DC analysis to perform time-varying simulation. Time-independent DC sources are set to their DC values, whereas, in case of pole-zero analysis, Ngspice calculates the number of poles and zeros in the AC analysis of small signals.

Similarly, other analysis processes are performed at circuit temperature, which can be changed with TEMP and DTEMP options in Ngspice to allow temperature analysis at the same time.

Solves non-linear equations. Every circuit gives a linear or non-linear equation, of which the non-linear one is more difficult to solve during any simulation. Ngspice solves such equations using Newton Raphson algorithm, which is interactive and terminates on meeting required conditions. Although Ngspice is reliable is providing solutions to non-linear circuits, it fails during DC analysis if parameters are not set correctly or if connections are specified incorrectly.

Ngspice has been integrated into the most recent technology computer aided design (TCAD) tool, which is a general-purpose semiconductor simulator (gss) via a network interface.

Ngspice and its interfaces. Ngspice works with various graphical user interfaces (GUIs) depending upon the various operating systems and devices. The GUI on Windows is pretty simple and provides only program-text output, command history and command-line inputs when it comes to data inputs and uses Windows application programming interface (API) for plotting

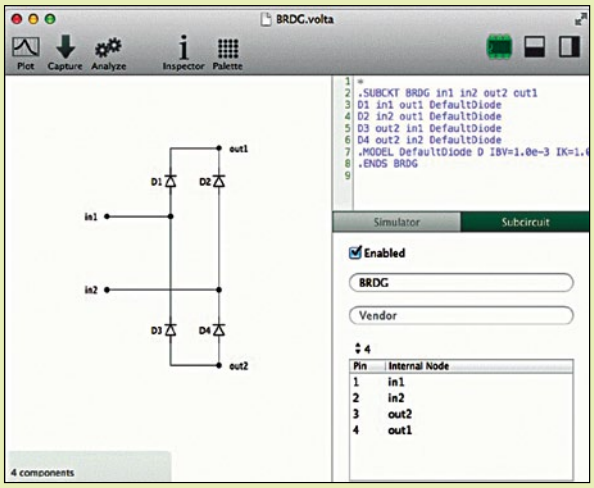


Fig. 4: Volta-ngspice GUI

data. Whereas on Linux, Ngspice uses a general console as a UI for input and X11 graphics system for output. CygWin interface that it works with is similar to Linux interface and also requires a console for input and X11 for output. However, it needs the following commands to initiate X11 Window Manager inside CygWin window before initiating Ngspice:

```
$ export DISPLAY=:0.0
$ xwin -multiwindow -clipboard &
```

Ngspice also has a Web browser based interface in which simulation takes place on a remote server and another online version available for iPads, though neither is directly related to Ngspice development project. Even on iPads, simulation takes place on a remote server.

Can be compiled as a shared library. Ngspice, when added to an application, allows that application to gain control over the simulator because of its feature that lets it be compiled as a shared library. This is done by an interface offered by shared modules that not only export the functions that control the simulator but also call back those functions to get the feedback. The interface thus offered is not from Ngspice and is provided by the calling process where the user can develop and optimise elements within the interface without making even a slight change in Ngspice source code. The source code of the API thus shared is available as sharedspice.c in a single C file, along with sharedspice.h as the corresponding header.

Returns data through call back functions. Ngspice uses call back functions to return data to the caller. These functions are globally-defined so that the C-coded Ngspice easily reaches to it. These functions can be easily identified as these are available as typedefs [for example, typedef int (SendChar)(char, int, void)]. The address of these functions is obtained from ngSpice_Init function, when the caller is initialised with this command.

What the users say

Users have different views regarding Ngspice. A user at *http://sourceforge.net/* considers it to be an extremely useful tool for circuit designing, and approves Ngspice community to be a major benefit to this tool. He compares with tools like Hspice and Spectra, which are too expensive to consider. Whereas, some other users on the same website consider these to be perfect tools and appreciate their application.

Another user at *www.electronicspoint.com/* considers Ngspice to be intelligent, providing values like 0.333333, 0.2 and 0.166666 because of its functionality to give errors when required, while he makes an error with PSpice providing numbers like 1/3, 1/5 and 1/6 that it considers to be 1.

Enhancements to Spice functionalities with the introduction of Ngspice is making this a popular tool with the available community support. The built-in models in this software act as a boon, allowing various types of analyses that are not always available in many other simulators.

Again, to get a free-of-cost simulator with so many features is quite difficult. ●

The author is a technical correspondent at EFY

CImg: A Powerful C++ Library for Image Processing

JAI SACHITH PAUL

CImg is a simple C++ toolkit intended to simplify the efforts of developers trying to implement new image-processing algorithms from scratch. A set of useful classes and functions that helps users to load/save, process and display various types of images is provided under a single header file CImg.h.

Computer scientists or student community working on computer vision and image processing will find this tool extremely useful. Even if you are a programmer, occasionally coming across some level of image processing, this tool will be of great help as there is no standard C++ library for this purpose yet. The package is distributed under CeCILL licence.

Motivation behind CImg

People who use image processing come from various scientific disciplines; we may find a doctor trying to have a better understanding of a patient's health condition with the diagnostic image of the patient's heart or a civil engineer trying to get an idea of a telemetric image of a dam to find out how strong it is. There could be a mathematician, biologist or computer programmer making use of image processing. A doctor might have a working knowledge of programming but we cannot expect him to know every minute detail of C++. Also, we cannot expect all users to deal with the same kind of images for their image-processing requirements.

So, the design of a general-purpose image-processing tool should cater to the needs of people working on different kinds of images and having different programming capabilities. These designs should follow some basic rules that ensure simplicity, genericity, usefulness, extensibility, portability and freedom of use of the library. CImg library was developed keeping in mind all these design considerations.

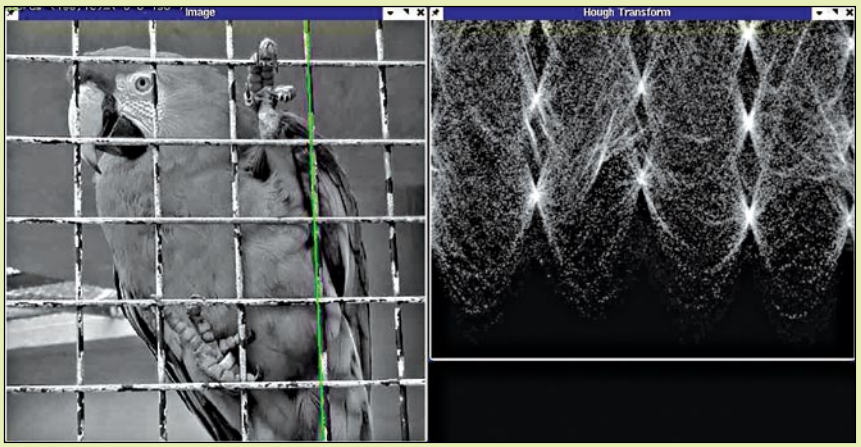


Fig. 1: Using CImg for computation of Hough transform to detect lines in 2D images

CImg classes

The namespace CImg library encompasses all classes and methods. There are four classes included in CImg library, in which only the first two have one template parameter.

CImg. This class represents an image having width, height, depth and spectrum as dimensions. A simple linear buffer stores the pixel data.

CImgList. This class represents a collection of images of varying sizes.

CImgDisplay. This class represents a display window. We can have multiple windows and user interactions that could be managed through class methods.

CImgException. When errors are encountered in the library method, CImgException class throws exceptions.

The framework

A handful of functions are included in order to write complex algorithms using minimal code. Let us take a look at some of these:

Supported file formats. CImg supports a large number of input and output file formats. These include joint photographic experts group (JPEG), 16-bit portable network graphics (PNG), 3D object file format, tagged image file format (TIFF) and more.

Image drawing. In order to facilitate drawing on images, there are many methods such as lines, polygons, ellipses, texts and vector fields.

Usual image-processing operators. These include filters, interpolators, fast Fourier transforms (FFTs), histograms, colour-base conversions and non-linear blur/sharpening, among others.

Arithmetic operators. Usual arithmetic operators like cosine, square-root and inverse tangent are available.

Expression evaluator. Synthetic

images from mathematical formulae can easily be generated with the help of a numerical evaluator of mathematical expressions in CImg. There are many functions to generate 3D vector objects from dense image data.

3D object viewer. The framework is composed of a 3D object viewer. For 3D rendering, CImg does not rely on external libraries.

Entire library under one header

If you are a professional C++ programmer, perhaps you would be surprised to notice that the entire library is written under a single header file. A bulky code might be time-consuming, but arranging these under different header files is not the best solution, as you might require all of these.

Of course, you can get the library precompiled. Yet again, this is not a good option because of the generic nature of the library.

Library is based on template data types. As in the case of a standard template library (STL), it is not possible to precompile library classes and functions of all possible data types.

CImg library is based on template data types, where users have the freedom to opt for the type of image that is represented by their respective codes. There will be a lot of possible combinations of classes, functions, arguments and data types, and the size of the object binary file generated to cover all possible cases will be huge. Compiling on the fly with users' codes, in turn, introduces a lot of flexibility for the users while coding.

Fig. 2: Image restoration and inpainting using Tschumperlé-Deriche algorithm

Supported platforms

The software is highly portable. It has been successfully compiled under the following configurations:

PC Linux 32-bit, with g++
PC Windows 32-bit, with Visual C++ 6.0
PC Windows 32-bit, with Visual C++ Express Edition
Sun SPARC Solaris 32-bit, with g++
Mac PPC with OS X and g++

Although external functionalities and libraries could be used to do more specific tasks, the minimal version of CImg can be compiled only with standard C++ headers.

G'MIC: A full-featured image-processing framework

Despite its simplicity and usefulness, CImg toolbox is not devoid of drawbacks. One main disadvantage is the prerequisite of knowing C++. Some users who would be interested in some functionalities of CImg might not have sufficient knowledge of C++.

GREYC's Magic for Image Computing (G'MIC) is a full-featured image-processing framework based on CImg library. It provides many user interfaces (UIs) convert, manipulate, filter or visualise generic image datasets in varying dimensions. We shall have a detailed discussion on this tool in a later issue of EFY Plus.

Interdependent classes. There are only four classes used in the library. Out of these, CImg and CImgList representing an image and a collection of image are the most important. Both these classes are interdependent. Even if we are defining these under different headers, we have to include both. Therefore in practice we do not gain anything in defining these under different header files.

Simplicity guaranteed. When the entire code is put under a single header, at first sight it may look like a total mess. But after thorough observation, we would realise that these are well-organised and structured.

From the user's perspective, installation is as simple as putting CImg header in the source directory.

For the developer, maintenance of the code is pretty easy. If the developer is in search of a piece of code, he or she can easily spot it in the library.

Users' reviews

Reviews on websites like *http://sourceforge.net/* indicate that the users are quite happy with the tool. The generic nature of the tool to suit various applications, and the simplicity and flexibility it offers, attracts many users.

A user writes, "I have been using this library for developing simple demonstrative projects and for testing my ideas in a fast and efficient way. The library is simply amazing in what it offers to you as a single-header file with very little project headache."

Some users are concerned about documentation. "The tool is a remarkable application having C++ features. It is astonishing that it is usable with just the include file, without linking to external libraries. I do not know how this was achieved. It needs a lot of work on documentation, though. I spent weeks trying to figure out even very simple things, but there are people in the forum who can help in this regard," points out a user.

A cool image-processing framework

The framework is aptly named CImg, an acronym for 'Cool Image.' The tool is not specific to any particular application, so anyone really interested in image processing can make use of it. The latest version of the software is provided in this month's EFY Plus DVD. Make sure to give it a try! ●

The author is an electronics enthusiast

INDUSTRY NEWS

Electronics to drive growth, revenue and employment

The government of India has received proposals worth ₹ 650 billion for electronics manufacturing in the country under modified special incentive package scheme (M-SIPS). Approval has been given to 21 electronics manufacturing clusters worth ₹ 90 billion.

IT industry body Nasscom and India Electronics and Semiconductor Association (IESA) have entered into an agreement to work together with the aim to push the share of electronics manufacturing and information technology (IT) to 25 per cent of the country's GDP by 2025.

India has been a global leader in building and delivering software and IT services, which contributes more than nine per cent of the GDP but its electronics market is almost entirely dominated by imports.

Both organisations would work on identifying key growth areas, facilitate business tieups among members and work with the government for setting up an incubation centre.

India to oppose WTO move to expand ITA products list

India will oppose any expansion of the products list under Information Technology Agreement of World Trade Organisation (WTO), whereby signatories, including India, are committed to the total elimination of customs duties on IT and electronics products.

The Department of Electronics and IT (DeitY) has said that, any such move would hurt the Make in India initiative and discourage investments towards local manufacturing of electronics products. Last year, the country had attracted ₹ 220 billion worth of investment proposals from multinationals.

Certain world powers have been pushing for adding around 256 products to the list that has not been updated since the treaty was signed in 1997, which, if implemented, will remove tariffs on an additional US$ 1 trillion global trade, annually.

Currently, 203 ICT products, including laptops, mobile devices, network equipment and set-top boxes are covered under the ITA. About 75 WTO countries, including the USA, China, Japan and all 27 European Union nations, are signatories to it.

Low-cost OLED screens top priority for researchers in India

G. Rajeswaran, leader of the team that developed organic light emitting diodes (OLEDs) in Eastman Kodak, has plans to bring in a disruptive technology to kickstart domestic manufacturing in OLEDs. IIT Madras is partnering him in the endeavour. Rajeswaran and IIT Madras are developing the initial ideas for an R&D project to manufacture OLED screens at a low cost in the country.

If approved and funded by the government, this ₹ 500 million project could develop processes that are required for an entrepreneur to set up manufacturing facilities at less than ₹ 1 billion.

STPI, IESA to set up Electropreneur Park

Software Technology Parks of India (STPI) has partnered with India Electronics and Semiconductor Association (IESA) to set up an Electropreneur Park, which is aimed at supporting 50 start-ups working on electronics product designing and development over the next five years.

The initiative has a corpus of ₹ 220 million, and will focus on IP creation and product development to increase value addition in domestic manufacturing of electronic items like smartphones, smartmeters, micro ATMs and set-top boxes.

India's solar capacity set to double this year

India is set to double its installed capacity of solar power this year, claims a new forecast done by the Mercom Capital Group. It revealed that more than 2GW of capacity will be installed in 2015, compared to

In Focus

Kazuo Ninomiya named Nikon India MD

As managing director Hiroshi Takashina moves to take charge of Nikon's Chinese operations, Kazuo Ninomiya takes over as managing director for India.

Rohit Sandal joins Lenovo as India HR head

Chinese computer technology company Lenovo has appointed Rohit Sandal as India HR head. Sandal will be responsible for handling the company's HR strategy and operations in India.

Ashok Lalla quits Infosys

After three years as global head - digital marketing of Infosys, Ashok Lalla has decided to move on from the company. He will now play digital advisor to brands and agencies.

Kiran Visweswaraiah appointed as new GM of Bharat Electronics

Kiran Visweswaraiah has taken charge as the new general manager - international marketing of Bharat Electronics Ltd (BEL).

IBM hires Stephen R. Pratt for billion-dollar Watson project

Former Infosys consulting head Stephen R. Pratt has joined the world's biggest computer services company, International Business Machines (IBM), where he will work on the company's billion-dollar path-breaking Watson project.

1GW installed in 2014. This forecast was made following some recent developments in Tamil Nadu.

Latest reports have revealed that Tamil Nadu Generation and Distribution Corp. has signed several power purchase agreements (PPAs) recently. Reports have also confirmed that a total of 400MW of PPAs have been signed in the state, with certain projects slated to be commissioned as early as September.

Another incentive for the Indian solar sector is renewable energy being included by the RBI for priority lending, but with a cap of ₹ 150 million for renewable energy generators and ₹ 1 million per borrower for residential customers. However, according to Mercom, impact of this policy would be minimal in the short-term, because the Indian solar market mostly comprises large-scale projects at the moment.

CEL, KINFRA to set up electronics park in Kochi

Central Electronics Ltd (CEL) and Kerala Industrial Infrastructure Development Corp. (KINFRA) has plans to set up an electronics manufacturing cluster in Kochi to give a push to Make in India campaign. CEL is a public-sector undertaking under the union ministry of science and technology, while KINFRA is a state-owned corporation.

Union minister for science and technology and earth sciences, Harsh Vardhan, has extended support to the project, which is spread over 45 acres of land and is expected to generate 10,000 direct jobs, according to G.C. Pillai, managing director, KINFRA.

Keltron, the first state electronics development corporation in Kerala that ventured into electronics manufacturing in 1973, will also be part of this initiative.

Philips India to focus on LED

Philips India is demerging its lighting business to focus on the fast-growing LED lighting market in the country in line with its global strat-

Calendar of Forthcoming Electronics Fairs/Exhibitions/Seminars/Events

Name, Date and Venue	Topics	Contact address for details
Strategic Electronics Summit (SES) 2015 July 30-31, 2015 BIEC, Bengaluru	A platform for the Indian industry to explore opportunities to work together with the defence establishment, bringing all stakeholders and share information	ELCINA Electronic Industries Association of India Phone: +91-9911445890 Website: www.elcina.com
BFSI Innovation & Technology Summit August 20, 2015 Mumbai	Explores key aspects, issues related to the BFSI sector, their practices and applications as business drivers for innovation and growth	Exito Media Concepts Pvt Ltd Phone: 080-42015540 Email: enquiry@exito-e.com Website: www.bfsiitsummit.com
8th Edition IPCA Electronics Expo India 2015 August 20-22, 2015 Pragati Maidan, New Delhi	A platform to source latest electronic components, equipment and services. The exhibition demonstrates the latest trends in the industry	IPCA Electronics Expo India 2015 Website: www.ipca-expo.com
6th World Renewable Energy Technology Congress - 2015 August 21-23, 2015 Manekshaw Centre, New Delhi	An international platform for promoting the global renewal energy industry	6th World Renewable Energy Technology Congress - 2015 Website: www.wretc.in
AUTOMATION 2015 August 24-27, 2015 Hall No.1 & 5, NSE–Mumbai, Mumbai	Catering to industrial automation, robotics, drives and controls, logistics, hydraulics and pneumatics, and building automation	IED Communications Ltd Phone: 022-22079567, 22073370 Email: jyothi@iedcommunications.com Website: www.iedcommunications.com/index.php
Embedded Systems Technology Forum September 2-4, 2015-05-14 NIMHANS Convention Centre, Bengaluru	A conference and exhibition that caters to the requirement of the electronics engineering community in India	dmg events Email: aneesahmed@dmgeventsme.com Website: www.estf.in
IFA Berlin September 4-9, 2015 Berlin, Germany	World's leading trade show for consumer electronics and home appliances	Messe Berlin GmbH, Messedamm 22 Phone: +49-30-3038-2217 Email: vonderropp@messe-berlin.de Website: b2b.ifa-berlin.com
electronica India productronica India September 9-11, 2015 Pragati Maidan, New Delhi	Fair for electronic components, systems, applications and entire value chain in electronics production, besides communication platform for the electronics industry	MMI India Pvt Ltd Phone: 9967558496 Email: kavita.chhatani@mmi-india.in Website: www.electronica-productronica-india.com
IT ASIA 2015 September 25-27, 2015 Hitex, Hyderabad, Telangana	An India international exhibition and conference on electronics and ICT industry	Aakar Exhibition Pvt Ltd Email: sanjay@mait.com Website: www.itasia.in
Safety & Security Asia 2015 Singapore September 29 – October 1, 2015 Marina Bay Sands, Singapore	One of the largest international safety and security technology and equipment exhibition	Conference & Exhibition Management Services Pte Ltd Phone: +65 62788666 Website: safetysecurityasia.com.sg
Taitronics 2015 October 6-9, 2015 TWTC Nangang Exhibition Hall No.1, Nangang District, Taipei, Taiwan (R.O.C.)	Electronic components and parts, meters and instruments, LED lighting and applications, power supplies, industrial process and automation, smart living and consumer electronics, broadband products and cloud	TAITRONICS 2015 (41st Taipei International Electronics Show) Website: www.taitronics.tw
Gizworld Wearable Tech and IoT SF conference October 27, 2015 Santa Clara Convention Centre, Santa Clara, California, the USA	Over 20 dynamic TED-style keynotes, 50 fast-track start-up pitches, product demos and unique networking opportunities	Gizworld Wearable Tech and IoT SF Website: gizworldconf.com/san-francisco
CeBIT India October 29-31, 2015 BIEC, Bengaluru	A digital marketplace to understand what new technology can do for a business	Hannover Milano Fairs India Pvt Ltd Phone: +91-22-66875527 Website: www.cebit-india.com
OSI Days 2015 November 19-20, 2015 Nimhans Convention & Exhibition Centre, Bengaluru	Open source conference that aims to nurture and promote the open source ecosystem in Asia	EFY Enterprises Pvt Ltd Phone: 011-26810601/2/3 Email: info@osidays.com Website: www.osidays.com
LED Expo 2015 December 3-5, 2015 Pragati Maidan, New Delhi	Country's No. 1 exhibition on LED lighting products and technologies	Messe Frankfurt Trade Fairs India Pvt Ltd Phone: 022-61445900 Website: www.theledexpo.com
Energy Storage India December 8-9, 2015 India Habitat Centre, New Delhi	International conference and exhibition on energy storage and microgrids in India	Customised Energy Solutions Website: www.esiexpo.in
WIN India December 9-11, 2015 Pragati Maidan, New Delhi	From hydraulics and pneumatics to electro-mechanical transmission, automation components to process and factory automation systems, among others	Hannover Milano Fairs India Pvt Ltd Phone: 9167522998 Email: nikhil.desai@hmf-india.com Website: www.win-india.com
India Electronics Week January 11-13, 2016 Bengaluru	An Indian exhibition for the global electronics industry showcasing concurrently five events: Electronics For You Expo, Electronics Rocks, T&M India, LED Asia and IoT Show	EFY Enterprises Pvt Ltd Phone: +91 11 40596605 Email: growmybiz@efy.in

Calendar of Forthcoming Electronics Fairs/Exhibitions/Seminars/Events

Name, Date and Venue	Topics	Contact address for details
WEARABLE EXPO January 13-15, 2016 Tokyo Big Sight, Tokyo	Wearable device and technology expo	WEARABLE EXPO Show Management Reed Exhibitions Japan Ltd Website: www.wearable-expo.jp/en
ELECRAMA 2016 February 13-17, 2016 BIEC, Bengaluru	Serves the business needs of utilities, government, EPC consultants, contractors, electrical equipment manufacturers and generation companies	ELECRAMA 2016 Email: anil.nagrani@ieema.org

Look up under 'Events' section in www.electronicsforu.com for a comprehensive list

Since this information is subject to change, all those interested are advised to ascertain the details from the organisers before making any commitment.

Snippets

Compact Lamps to set up new plant for LEDs

Compact Lamps is set to target a turnover of ₹ 10 billion in three years as it forays into the LED lighting segment with its own brand. The company also has plans to invest ₹ 1 billion for setting up a new plant for LEDs. At present, it has four plants with a production capacity of two million units per months in Uttarakhand.

EIIL to sell India-made LED lights

Dry-cell battery maker Eveready Industries India Ltd (EIIL) has announced its plans to switch to made-in-India LED lights. The company aims to generate revenue of more than ₹ 7 billion from the segment in the next couple of years. At present, it sells LED lights that are outsourced from China.

NI unveils Wireless Innovation Lab to advance 5G research

NI has announced the opening of the new Wireless Innovation Lab at its Austin, the USA headquarters. In the lab, NI supports ongoing collaborations with top academic and industry research groups participating in its RF/Communications Lead User programme. Current demos and projects on display in the lab include mmWave mobile systems, 5G massive MIMO testbed and LabVIEW Communications System Design Suite.

egy to drive value in its core business areas. Accordingly, 40,000-odd public shareholders in Philips India, who hold about three per cent stake, will get shares in the new demerged lighting business on 1:1 basis. The Dutch parent, Royal Philips, holds the balance 97 per cent in the Indian entity, which was delisted 11 years ago from Indian bourses with minority public shareholding.

The diversified technology company has also set up an independent company, Philips Lighting India Ltd.

The company will also expand its LED manufacturing capacity at its two plants at Vadodara and Mohali.

Innolux looks to invest in India

Taiwanese panel-display maker Innolux has plans to invest in India in order to expand its presence in the Indian subcontinent with its biggest shareholder and key supply-chain client, Hon Hai Precision Industry.

According to a spokesperson from Innolux, there were issues regarding finding local partners and clients if the company wanted to enter India by itself. Hon Hai, whose trade name is Foxconn, owns about eight per cent of Innolux through direct and indirect holdings.

In May, Hon Hai chairman, Terry Gou, said that his company, which is the world's biggest contract manufacturer of electronic products and the key assembler of Apple's iPhones, aims to develop around ten facilities in India, including factories and data centres, by 2020.

OPPO to set up handset manufacturing unit in India

Chinese handset maker OPPO, which entered the Indian market in January last year, will soon be setting up a handset manufacturing unit in India by August, where it will make smartphones for India and overseas markets.

2015 will be a year of expansion for the brand that has presence in North America, Europe and Asia.

The company is among the top three players in Indonesia, with more than 11 per cent market share. It owns 13 per cent of the Vietnamese device market and almost 11 per cent in Malaysia.

iPhones to be manufactured in Maharashtra

Apple's signature smartphone, iPhone, may soon be manufactured in Maharashtra as the state government is reportedly keen on attracting companies such as Foxconn from China.

Chief minister Devendra Fadnavis, who was a part of PM Narendra Modi's recent delegation in China, visited Foxconn's manufacturing facility in the Henan province. Fadnavis said that the state government was in talks with the company to set up a manufacturing plant in Maharashtra as well. It is believed that the chief minister is quite keen on boosting the new manufacturing plant in the state, thereby providing employment opportunities as well as attracting many youngsters to join the workforce.

Mitsubishi Electric to make elevators and escalators in India

Mitsubishi Electric Corp. has announced that its Indian elevator operations, Mitsubishi Elevator India Pvt Ltd, will build a factory in Bengaluru to strengthen local competitiveness and expand its business in the world's second largest market for elevators and escalators.

The new factory in Bengaluru is on a site of 89,000sqm with a floor space of 25,400sqm. Operations are to commence by July 2016, with a production capacity of 5000 units annually. Established with an investment of ₹ 1.8 billion, the factory will have adjunct facilities including a 41m high elevator-testing tower and a field-training centre.

Product Quality Perceptions of Chinese SMEs and the Best Option to Buy Quality Products from China

P.S. Deodhar is Life Fellow, IEEE, the USA

I have 55 years of experience as a designer of electronic products for professional use. I have been manufacturing these with the best quality possible for our Indian and European customers. I have also been a buyer of components and equipment in bulk during my ten years with the government in Delhi as chairman of Electronics Commission and managing ET&T, central government's trading company. Quality has been my prime concern, and I have managed to imbibe quality as a work culture of the organisations I have worked for and its deployment in production and customer service.

I have had a chance to take a close look at China's SME sector when, in 2008, I travelled to China and visited 231 SME companies in seven urban production hubs in China, and personally interviewed them. This was part of a project for India-China Economic and Cultural Council to study the growth and success of China's SME sector and identify reasons for their spectacular growth. During my visit, quality of Chinese products was the major aspect of the study.

What is quality

In the course of almost six decades in an engineering career, I found that manufacturers have varied perceptions about quality of what they deliver. Most of them relate to delivering quality that customers demand. Most, therefore think of quality as something that meets or exceeds customer's expectations. Others think that, even in a more limited sense, quality means 'meeting what customer will accept.'

Workers in an electronics factory in Shenzhen, China (Image courtesy: wikimedia.org/wikipedia/commons)

More conscious ones think of quality as delivering more than customers would want by making continuous improvements in their manufacturing and business processes. They anticipate what customers would want and work towards giving the best value for the price realised and add to the customer value.

Some define quality as doing the right thing, in a right way, with the right people. Some are more abstract, they believe that quality is about meeting or exceeding the expectations of clients, employees and the related community.

Then, of course, there is ISO certification that demands having in place the minimum level of quality systems, management processes and operational discipline. An ISO label becomes necessary to qualify as a supplier in India. Mid-size SMEs, who attend quality seminars, talk of Kaizen, Six Sigma, Taguchi, Quality Circles, TQM and other quality religions to evolve all-inclusive quality culture. In China's SMEs, this is not very common, though.

In 1982, I was first exposed to the Chinese manufacturing sector when APLAB, of which I am a founding member, started exporting large quantities of test equipment like oscilloscopes to China. We were the only company in India to export electronic products to China.

Chinese manufacturing was in a mess as far as quality was concerned. Then, Deng Xiaoping dramatically changed the course of China's industry via EPZs, as in Taiwan and South Korea. A huge number of western corporations moved their manufacturing to China since they could repatriate all their profits outside of China. Deng, thus, created a training ground for Chinese workers and engineers. They got trained to produce goods with high quality standards as demanded by European and American multinationals (MNCs). Entire China, in the process, got trained in quality engineering work using modern processes.

The smart Chinese personnel soon started leaving MNCs to start something of their own or become vendors of MNCs. Modern China learnt quality from export production, which became its quality culture. When work was outsourced to SMEs by these foreign firms, they taught their vendors the right processes, demanding quality.

Then, in late-1990s, these SMEs started exporting to other countries. That is when quality took its toll. The world rushed to buy from China and these trader importers taught Chinese to reduce the quality for a cheaper price. China today has a large number of SMEs that produce products with high quality, but it also has many others mushrooming to offer low-priced products demanded by trader importers.

Delivering quality essentially demands good designs that meet assured or claimed performance, expertise in technologies involved, knowledge of choosing the right materials, control over processes and skills to implement these with diligence and sincerity. The core of this is pride of the team involved in design and workmanship. It demands creating and motivating mutually-supportive teams to produce and deliver a product that gives an organisation a sense of pride.

Before meeting customer needs, the organisation, however, needs to set even higher standards for the team than what the customers demand. The challenge is even more in doing so within target costs and prices. I often used to say to my team that we have to deliver champaign at the price of beer.

All the quality processes mentioned above essentially show proven ways to achieve that goal. Most of these, however, are regimental. One must inculcate quality as a culture and a way of life, not limited to just the production work in the confines of a factory.

I have found that SMEs everywhere in Asia, including India, have

several definitions for their quality goals, depending on how high up in the sky they choose to be. At the very least, it is about meeting customers' specifications. The better objective is to give customers a product that meets their need and continued efforts to improve processes. Some SME manufacturers feel that quality needs to be good enough to ensure that customers come back and products do not.

Unfortunately, most SMEs in India, China and other low-cost Asian countries, are still at the base level. For them, producing a quality product means complying with rules imposed by a customer. With that mindset, higher quality means extra inspectors for quality policing. They complain that it costs more money. One Chinese SME said, "If customers use statistical quality-control standards based on acceptable quality level (AQL) limits, or if buyers set a tolerance tighter than what is usually considered normal for general consumer goods, they will raise the price".

This mindset is reactive and not proactive. The manufacturer here does not wish to take any initiative to improve the design and production process but simply tighten the in-company inspection of quality.

I have observed that Chinese SMEs, like in India, consider quality and price to be tightly-linked. One conscious of quality must refuse to produce low-quality products, as happens in Germany or Japan. I find that trader importers too focus on low cost. They too get lured by nice samples that they see or receive from China and by their low price, not realising that sample quality is not indicative of mass production quality, and many, eventually, regret receiving products in bulk that are not up to the standard of the sample.

During my SME study in China, I found that Chinese do not like Indian trader importers. There is a cultural disconnect. Chinese wonder how anyone can demand high quality and also pay a low price. If the price is low, quality should be expected to be low, they say.

The problem is, Chinese SME suppliers, in a vast majority, are incapable of illustrating what quality standard they follow. Any reputed company that cares for its quality reputation will refuse business than dilute its benchmark quality. But, most Chinese suppliers are willing to accommodate such customers, who are willing to accept cheap goods. It is common in China for manufacturers to explain the difference for several pricing levels.

Let me, for a moment, move away from SMEs and talk about the concept of quality in the new business paradigm. A lot of us are not aware that iPhone 4 had several problems and Apple was aware of those. Yet, they released that version to avoid delaying the launch. They knew that they might have to replace some iPhones for free. It was considered the least-costly solution to their company. For them, the problem was known but they were sure that only a minority will detect it. In fact, free replacement for a few even raised the value of the company in the eyes of the customers. They knew that problems were minor and acceptable to risk the release.

The same thing is largely true of many software products, classically, Microsoft's Window versions. This probably happens in other markets too because manufacturing is now controlled by businessmen with MBAs, rather than technologists like in Germany or Japan. Money has become a centre-piece, not quality. Companies have now become commodities for corporate growth.

Getting quality goods from China

One of the biggest barriers in China is language. Chinese SME suppliers do not speak or understand English and their business perceptions too are different. I, certainly, therefore believe that pre-shipment inspections are important to secure quality from China. That is why, in 2003, I set up a company in China to help ourselves and other friends' world over to find the right sources and get assurance that we could get quality goods.

In order to secure on-time delivery of quality goods from Chinese suppliers, you will need to consider three areas.

1. Your supplier needs to be a genuine manufacturer. Many Chinese manufacturers found on the Internet are just catalogue/website companies. You can never get quality from a Chinese supplier who is not properly equipped to manufacture products; such as, the right test and production equipment, necessary skills and experience. He also should be willing to cooperate with you on regular improvements.

2. You need a local arm to work upstream to further reduce the risk of getting below-standard goods, instead of just filtering these at the end of the process. Local check is necessary even though quality remains the responsibility of the supplier. One must go deeper and dig in the details of what actions the supplier has implemented to fulfil the desired quality. Even after you have identified a good supplier, you will want to review the quality-control plan to make sure that all aspects are covered. One needs to be explicit in highlighting quality requirements and expectations. Many misunderstandings will be avoided during this step.

3. Pre-shipment inspection is always good insurance. There is no point in carrying out the inspection and stopping poor products just before shipment. What good it is for your business if you do not get the desired product at the right time? Discussing the inspection plan with the supplier is the best way to avoid this.

In my experience, there is no shortcut to the above-mentioned steps. Even if you are lucky enough to find a good supplier, you must follow these steps so that the process is faster and more straightforward. ●

MARKET SURVEY:

Safer, Smarter, Greener Mobility

Fuelling Automotive Electronics in India

Sudeshna Das is senior executive editor at EFY

Automotive electronics plays an important role in sensing, computing and actuating the different features and functionalities of a car. "In the 1980s, total electronics content of a car accounted for around three per cent of the total vehicle value; today, it is more than 20 per cent and by 2020, it is likely to further increase to 35 per cent," says Edoardo Merli, director, marketing and application automotive product group, Greater China and South Asia Region, STMicroelectronics, while discussing the growth potential of the Indian automotive electronics market.

Automotive electronics has gained importance on account of the growing consumer demand for performance, safety, comfort, convenience and entertainment from their vehicles. The car of the future is expected to be equipped with even more advanced features that would help prevent accidents, entertain occupants and at the same time, be gentler on the environment. In fact, in the not-so-distant future, cars may not require drivers at all.

"With growing demand around safety, comfort and entertainment, electronification of the automobile will be key. In addition, stricter emission norms make it necessary to have more electronics in the vehicle," says Prabhu Panduranga, managing director, Bosch Automotive India Ltd.

Given that, one of the ways automotive companies look to expand their market share is by introducing novel features and most of these features are driven by electronic components, the auto-electronics segment can continue on a positive run even if the auto sector as a whole underperforms.

In this report, we will take a peek into the significance of electronics in the evolution of automotive technology, followed by a discussion on the capability and growth potential of the Indian automotive electronics sector.

From mechanical to electronic

Innovation in automotive electronics has grown in leaps and bounds in the last four decades, driven primarily by advancement in microcontroller (MCU) technology and software systems that control vehicle systems.

"Adoption of electronics in the automotive sector began in the 1970s, with the use

of radios, alternators and voltage regulators that controlled the alternators. Engine management was the next big thing with the introduction of electronic fuel injection technology. Majority of the innovations in sophisticated engine management and transmission control have been driven by electronics through the use of MCUs, semiconductor switches and sensors. Moreover, low-cost and reliable electronics have also made body and convenience applications more efficient and standardised in modern vehicles," explains Rajeev Ramachandra, chief technology officer and co-founder, Mistral Solutions.

Application of electronics has since expanded to other vehicle systems from the days of the radio and alternator. Many sophisticated safety systems in modern cars would not have been possible without the use of electronics. In addition, the recent convergence of communication and entertainment needs have also driven rapid development of the infotainment segment in vehicles.

These developments have been made possible through the substitution of mechanical parts by electronics, more precisely, the marriage of mechanical actuator parts with electronics to develop a new area known as mechatronics, which facilitated further growth of the automotive electronics industry.

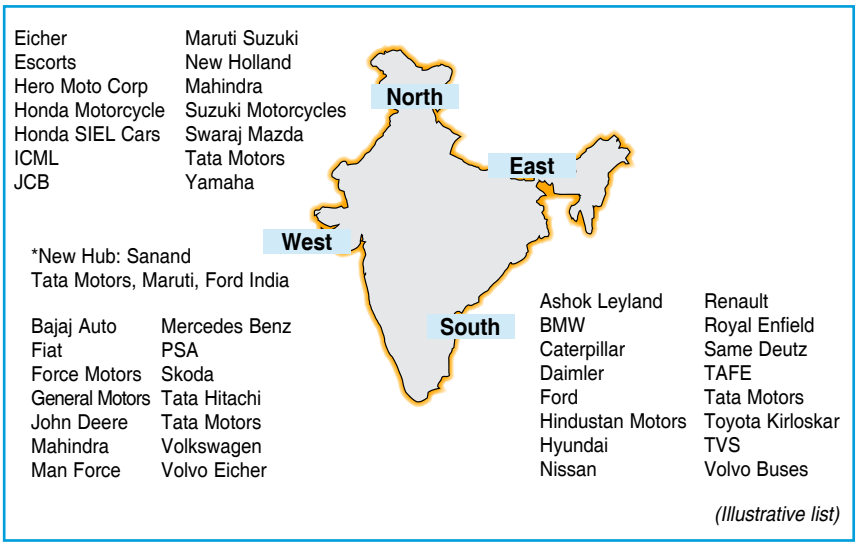


Fig. 1: Significant automotive manufacturing base of OEMs: Indian and global (Source: ACMA)

Tracing automotive electronics innovations

1970s: Introduction of electronics for engine controls
1980s: Introduction of anti-lock braking
Early 1990s: Standardisation of airbags
Late 1990s: Rapid expansion of body electronics, such as seat motors (body computers), instrument panel lighting, auto-locking systems and keyless entry
Early 2000s to date: Infotainment including sophisticated audio and video, signals sent via satellite (such as OnStar System), GPS and mapping capabilities, and satellite radio
Late 2000s: Steer-by-wire, wireless connectivity

Source: Infineon

India riding the growth wave

The automotive electronics industry, a sub-set of the auto components industry in India, grew out of the offshore transfer of automotive design centres by multinational semiconductor manufacturers to leverage the country's IT expertise in design, development and simulation.

India has been seen as a base for prototyping, testing, validation and production. Global automotive original equipment manufacturers (OEMs) are also shifting automotive research and development (R&D) centres to India not only to take advantage of cost arbitrage but to also incorporate relevant design customisations to suit the local market. Moreover, automotive electronics manufacturing is also gaining importance in the country.

Where does India stand in automotives

- Largest tractor manufacturer
- Second-largest two-wheeler manufacturer
- Second-largest bus manufacturer
- Fifth-largest heavy truck manufacturer
- Sixth-largest car manufacturer
- Eighth-largest commercial vehicle manufacturer

Source: ACMA

The Indian auto components industry is expected to register a turnover of US$ 66 billion by 2015-16 with the likelihood of touching US$ 115 billion by 2020-21, depending on favourable conditions, as per the estimates of Automotive Component Manufacturers Association of India (ACMA). In addition, industry exports are projected to reach US$ 12 billion by 2015-16 and add up to US$ 30 billion by 2020-21.

Future growth of automotive electronics industry in India will be driven primarily by the rapidly growing passenger car market, adoption of automotive electronics, and consumer behaviour and demand.

Rapidly growing car market. The Indian automotive industry is witnessing a phase of rapid transformation and growth, driven primarily by stable economic growth and a focus on infrastructure development. In the past two decades, the country has become a favourite destination of global OEMs for offshore transfer of production due to low production cost and increasing local demand. This, in turn, has contributed to the development of some major automo-

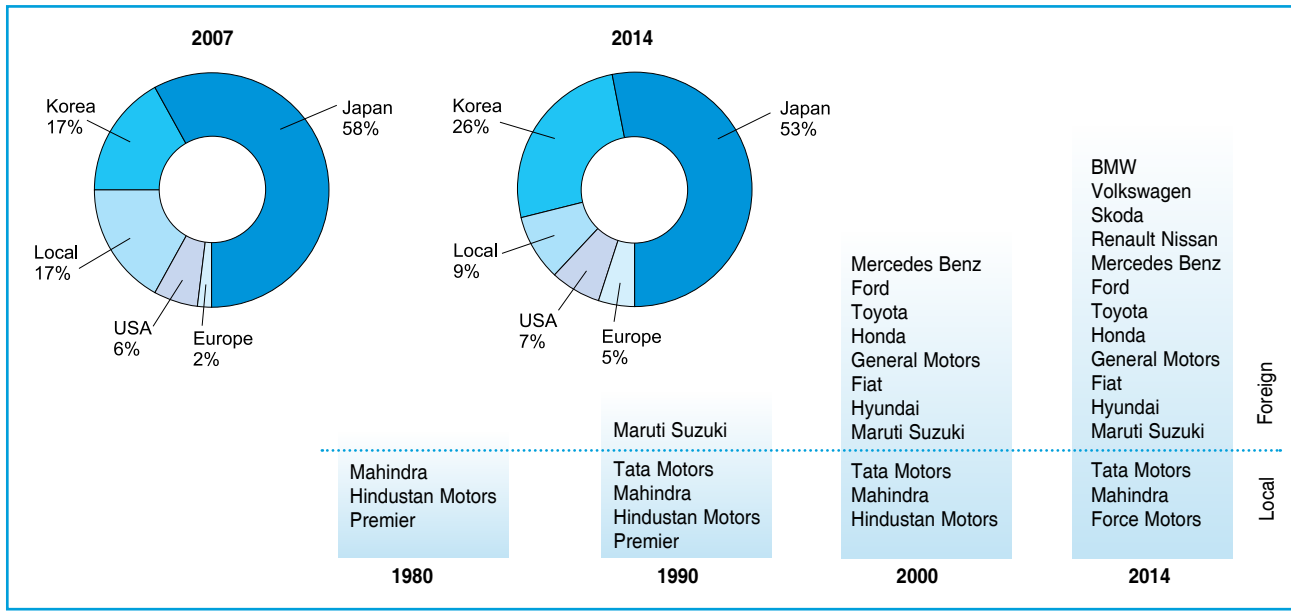


Fig. 2: Rapidly growing presence of global OEMs in India (Source: ACMA)

tive clusters across the country (Fig. 1). In comparison with the 1980s, when only a few local OEMs were present, India is now a manufacturing hub with significant presence of global and local OEMs (Fig. 2).

"From being a low-key supplier providing components exclusively to the domestic market, the industry has emerged as one of the key auto centres in Asia and is today seen as a significant player in the global automotive supply chain," says Nitin Pai, senior vice president, TATA Elxsi.

While specifying the opportunities that exist for automotive electronics, S. Ganesh Kumar, country sales manager, Atmel R&D India Pvt Ltd, opines, "Indian automotive product range varies from ultra-low-cost as the majority share up to mid-level cars. Each of these specific target products definitely requires some sort of electrification and electronic controls to enable highest efficiency and achieve some sort of comfort level. All these requirements create the potential for automotive electronics."

In addition, the two-wheeler segment, which dominates the automotive market in India, and commercial vehicle segment also show demand for electronics.

Adoption of automotive electronics. In the early years of the automotive industry in India, manufacturers would use streamlined manufacturing processes as their competitive advantage as opposed to innovation. Electronics features, adopted by global car makers, would typically be given a miss by their Indian counterparts.

Process efficiency having reached its peak, the focus is now on innovation or additional novel features that are based primarily on electronic components. In fact, regional automotive manufacturers and design teams of global manufacturers present in India are increasing their focus on utilising technology to differentiate themselves from their peers.

The need for reduced production cost, coupled with increased quality along with customisable novel features, all within shorter business cycles, is driving an increased focus on the role of electronics within the region's automotive manufacturers.

Electronics content will become more advanced with each new generation of vehicles produced in India. "Implementation of properly-designed electronic systems can even reduce cost, while increasing flexibility and reliability of a vehicle," says Ramachandra. This suggests great potential for the automotive electronics market.

Consumer behaviour and demand. Demand patterns of automotive electronics in the country are driven by local consumers and export requirements. Consumer needs typically focus around affordability, prestige, mobility, environmental conscience, safety, comfort and a host of other factors.

Affordability, for example, plays a huge role behind the miniscule share of the premium car segment in India. The ultra-low-cost (ULC) segment targeted by Tata Nano addresses the consumer's need for affordability, which is in head-on competition with the motorcycle—the current dominant form of private transportation in India. The major challenge for suppliers in this segment is to innovate technologically and business-wise in order to create a profitable and sustainable business model, keeping in mind price sensitivity.

A recent study, conducted by a team from *Electronics Bazaar*, among a select group of millennial or gen Y folks in the metro cities of India found that in-car electronics such anti-lock braking system (ABS), smart air-conditioning, power windows, and head and side airbags are

the features most wanted by prospective car buyers. The study also suggested that fuel consumption, cost-performance ratio, safety, price, design and comfort are considered to be the major selling points.

This is good news for the automotive electronics sector, which has been hard at work developing power train and chassis improvements designed to reduce fuel consumption and improve long-term cost-performance ratio levels. Factors like safety, comfort, telematics and in-car infotainment are also some of the current major industry themes. However, at the same time, it is important to note that Indian consumers who drive medium- or low-cost vehicles are interested in having the latest features in their vehicles that are also price sensitive in nature.

According to Pai, "Today, car makers are competing to bring in advanced features, connectivity, entertainment, advanced safety and improved fuel efficiency to their products to attract potential buyers. To address this ever-increasing list of consumer needs, more and more technological advancements are, and will keep, happening, and automotive electronics will play a pivotal role in satisfying all user requirements. This paves the way for complex electronic systems. Therefore providing cost-competitive electronic solutions is a challenge and an opportunity for Indian automotive companies."

Safer, smarter, greener options

According to an iSuppli Corp. report, technological development in engine management and incorporation of safety systems in cars are expected to be the key growth drivers for the Indian automotive electronics market in the next five years as it attains a compound annual growth rate (CAGR) of 21.8 per cent.

Electronics plays a key role in improving road safety. Safety applications in India are currently policy-driven, possibly due to the cost sensitivity of the Indian market. Car safety is set to receive a serious boost in the country with the government planning to make ABS, airbags and other safety equipment compulsory on all passenger cars sold in India. As per the proposal, India will have its own vehicle safety standard called India New Car Assessment Programme (NCAP), which is similar to United Nations' NCAP.

This would present a serious challenge for ultra-low-cost and two-wheeler segments as safety features found typically in higher-segment cars are expensive. This will also, no doubt, force automotive innovation in yet another direction, as car makers and suppliers attempt to meet emission and safety standards at a low cost.

According to Merli, increasing electronics content in the two-wheeler segment is likely to fuel the demand for optimised semiconductor solutions suitable for cost-sensitive markets.

Merli also pointed towards the huge scope that exists in the commercial vehicles space. In India, safety and emissions in commercial vehicles are a huge concern for regulatory authorities. This might result in setting new mandates in this segment. For example, ABS is now mandatory for commercial vehicles, which may be followed by regulations in tire pressure-monitoring systems (TPMSes). And eventually, all these will result in increasing the electronics content in commercial vehicles, too.

Emission reduction also poses a major challenge for the Indian commercial vehicle manufacturers, and regulations with respect to emission would be made mandatory in India soon, which would provide an impetus for growth in the Indian automotive segment, especially in power train and transmission.

In addition to ABS, incorporation of some advanced driver assistance systems (ADASes) will also help to make Indian cars safer and will definitely increase the electronics content of the cars. In this regard, Pai referred

Electronic consumption by the automotive segment

Power train and chassis
- Diverse electric motors
- Electrical (turbo) charging
- New igniters and advanced sensors
- Automated manual transmission
- e-braking, e-steering, e-suspension
- Electronic stability control
- Start-stop system

Safety
- Rear cameras
- Lane departure warning
- Adaptive cruise control
- Blind-spot detection
- Map-supported adaptive front lighting
- Tire-pressure monitoring system
- Curve warning
- Speed alert
- Collision warning/avoidance
- Usage data transmission

Telematics and infotainment
- Fixed and portable navigation devices
- Multimedia features
- Bluetooth
- eCall
- Voice based, haptic and human-machine interface (HMI) systems and touch
- Real-time traffic information
- Parking assistants
- Social media
- Wi-Fi hotspot, smartphone interface

Comfort and convenience
- Adaptive front lighting
- Steering wheel buttons
- Central/heads-up displays
- Voice-control systems
- Xenon headlights
- LED/ambient lighting
- Touchscreens
- Remote control
- Well-being assistants

Source: Frost & Sullivan Report, 2014

MAJOR CONTRIBUTORS TO THIS REPORT

Edoardo Merli, director, marketing and application automotive product group, Greater China and South Asia Region, STMicroelectronics

Nitin Pai, senior vice president, TATA Elxsi

Prabhu Panduranga, managing director, Bosch Automotive India Ltd

Rajeev Ramachandra, co-founder and vice chairman, Mistral Solutions

S. Ganesh Kumar, country sales manager, Atmel R&D India Pvt Ltd

Facts and figures: Indian automotive electronics market

- Automotive electronics account for around five per cent of the total semiconductor market size of US$ 7 billion
- On average, total electronics content of an Indian vehicle is around ten per cent, with an average value of US$ 50 per car and US$ 5 per two-wheeler

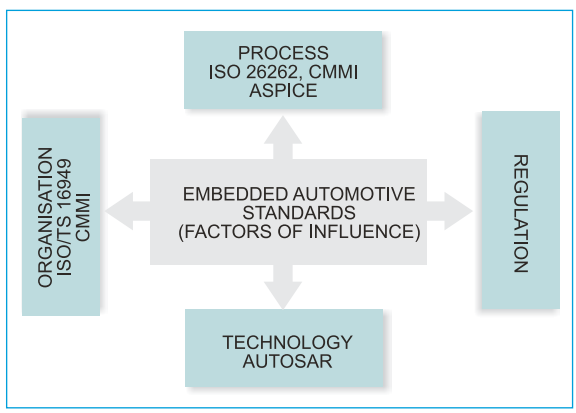


Fig. 3: Automotive electronics standards (Source: NASCOM)

to systems like lane-departure warning system that alerts the driver if he/she veers away from lanes, drowsiness detection system, blind-spot monitoring system that enables the driver to view areas around the car that are not viewable with standard mirrors and so on. Another area that might see additional inclusion of semiconductors will be in body control modules (BCMs), integrated systems for controlling various body peripherals like lighting, wipers and HVACs.

Harmonised development through standards

The growing amount of electronics in power train, chassis, body control and infotainment applications in passenger cars and vehicles in India make it increasingly challenging to manage development of complex embedded systems that integrate software and hardware from a large set of suppliers. Therefore adoption of globally-established standards will enable the industry to harmonise their development activities to compete effectively.

Standards governing the automotive electronics landscape can be presented as a triad of technology, process and organisation (Fig. 3). It is acknowledged that, standards are also driven by government policy and regulations (for example, legislative and emission), keeping in mind future demands.

Both Merli and Ramachandra point out that the significance of standards must be taken into consideration if the Indian automotive industry has to cope with the increasing vehicle system complexity and an increase in safety-relevant functions in embedded systems.

"From our perspective, quality standards within the India automotive industries are at par with any emerging developing country standards such as BRIC countries," opines Kumar.

Sustainable mobility

India is now paving the way forward in future mobility. Technological advancements are changing the way we think about cars in terms of energy efficiency, safety, comfort, car-to-x communication and even infotainment solutions, explains Ramachandra.

In future, security and connectivity would need to run hand in hand. For example, a user entering the car and connecting his personal device to the head unit would compromise vehicle security. While improved connectivity enables the car to access information continuously from the cloud and provide enhanced services to the driver and passengers, it also becomes vulnerable to potential hacking and even tampering of the controls of the vehicle, endangering its occupants. Pai suggests, enhanced security platforms such as secured gateway modules could act as a central hub and a gatekeeper between the vehicle and the outside world to prevent unauthorised access.

The ever-increasing functionality, applications, convenience and user-friendliness of smartphones and tablets have influenced the automotive industry to work on integrating these devices or similar functionality into the vehicle.

Presently, these devices can be paired to the head unit of the car and engage in a whole set of functions like voice calls, navigation and audio/video content. "Connected cars of the future will seamlessly integrate smartphones, wearables and sensors into the car, and provide users not only with applications such as cloud based navigation, real-time traffic updates, fuel reminders, location of parked vehicles and emergency/service assist, but also provide features such as active health monitoring

and personalising the driving experience of the driver," predicts Pai.

Further integration of connectivity features like Wi-Fi, DLNA and MirrorLink will enable users to have access to content on the move. According to Panduranga, however, connected car is the new trend with a lot of possibilities, but the industry needs some more time to evaluate its true benefits.

With increasing fuel costs and pollution levels, sustainable growth of the automotive industry depends on the use of alternative fuels and energy sources like fuel cells, solar power and electric power. Introduction of green technologies in the form of hybrid and electric vehicles would strongly increase the use of sophisticated electronic controls to achieve maximum efficiency and reliability.

"Electrification of cars using hybrid engines is one potential for exploration in India. For the short-term, full electric cars might not be suitable considering the electrical grid infrastructure and charging facilities required. However, hybrid engines enable the highest efficiency possible in specific usage environment, in addition to cutting back the pollution in cities," says Kumar.

While commenting on futuristic technologies, Ramachandra mentioned the need for complete control of the infotainment system as well as importance of collision-detection systems through car-to-car information exchange without any human intervention.

Make in India, on the way

According to Department of Electronics and Information Technology (DeitY), majority of investment proposals received by the department in the last one year for Make in India campaign are from the automotive electronics sector.

"As the industry requires coordination of logistics, basic infrastructure such as roads, networks, electric grid supply and support of all essential suppliers, these require effective government policies to support such growth," says Kumar.

While commenting on the possibility of increasing automotive electronics manufacturing in India, Panduranga opines, "With favourable investment policies and a large pool of talent, India does have a good chance of becoming a manufacturing hub."

He adds, "There are many schemes announced for the electronics manufacturing sector, which should encourage more investors to make in India. Both central and state governments encourage investments in the electronic system design and manufacturing (ESDM) sector. We are also one of the beneficiaries of modified special incentive package scheme (M-SIPS) scheme. It is moving in the right direction and I am sure more investments will happen in India. Special mention should be made about M-SIPS, where the entire process is handled in a transparent and professional way." ●

NEW PRODUCTS

COMPONENTS

Diode

Vishay Intertechnology has introduced 28 new 600V and 650V FRED Pt gen 4 ultra-fast recovery diodes optimised for high-frequency converters in power modules, motor drives, UPSes, solar inverters and welding machine inverters.

Offered as die in wafer form, the devices offer ultra-low forward voltage and reverse recovery charge to reduce losses and increase efficiency. Also, their extremely soft turn-off behaviour minimises over voltages under all switching conditions.

The devices are designed for use as anti-parallel diodes in combination with Vishay's Trench insulated gate bipolar transistors (IGBTs).

Vishay Intertechnology Inc.
Website: www.vishay.com

MOSFET

Toshiba has launched SSM6J507NU, a P-channel MOSFET, suitable for load switches of USB type C terminals conforming to the USB PD specifications. USB PD is a technology that allows a power supply of up to 100W (20V/5A), while a load switch between a USB type C terminal and battery charger integrated circuit (IC) is required to have an isolation voltage of 20V or higher.

The MOSFET is suitable for this application as it achieves VDss = -30V and a low ON resistance.

Toshiba India Pvt Ltd
Website: www.toshiba-india.com

ADC

Texas Instruments (TI) has announced ADS54J60, a 16-bit 1GSPS analogue-to-digital converter.

Key features of ADS54J60 are:

1. Allows higher frequencies with more accurate signal analysis

2. Offers more than 3dB better SNR (70dBFS at FIN = 170MHz), low noise floor of -159dBFS/Hz and spurious-free dynamic range (SFDR) of 86dBc

3. Offers two channels in a 10mmx10mm package

4. Reduces data interface speed and external processor resources

5. Offers 20 per cent low power consumption

Texas Instruments
Website: www.ti.com

DSP chip

ON Semiconductor has announced the release of BelaSigna 300 AM with AfterMaster HD Audio Labs Inc. BelaSigna 300 AM digital signal processing chip embedded with AfterMaster technology is an audio solution that enhances the listening experience on any consumer device.

ON Semiconductor
Website: www.onsemi.com

Controller

The STNRG digital-controller family from STMicroelectronics helps designers maximise the advantages

of digital power conversion, including high efficiency under all load conditions, enhanced safety, rich diagnostics and convenient network connectivity.

STNRG ICs contain ST's state machine event driven (SMED) high-resolution pulse-width modulation (PWM) generator, in combination with an STM8 based supervisory core. The devices integrate 32kB EEPROM, 6kB RAM, an ADC, op-amp, I2C port and GPIOs.

STMicroelectronics
Website: www.st.com

Intelligent power module

Infineon Technologies has launched an intelligent power module (IPM), MIPAQ Pro, which provides an all-in-one solution for a wide spectrum of scalable and compact inverter designs to be implemented in wind, solar and industrial drives applications. It is a fully qualified and tested IPM, integrating IGBTs, gate drivers, a heat sink, sensors, digital control electronics and digital bus communication in one robust device.

Infineon Technologies AG
Website: www.infineon.com

Front-end power module

Vicor has launched high-density, low-profile, integrated VIA PFM AC-DC front-end power modules that are capable of achieving a power density of 8W/cm³ (127W/in³), supplying an isolated, PFC-regulated 24V or 48V SELV DC output at up to 400W from the universal AC input range of 85V to 264V with 93 per cent peak efficiency.

Vicor Corp.
Website: www.vicorpower.com

TVS diode array

Littelfuse has introduced the miniature four-channel bi-directional SP1015 series TVS diode array (SPA diodes), designed to protect data lines that may experience destructive electrostatic discharge (ESD). These robust diodes can safely absorb repetitive ESD strikes (±20kV contact, ±30kV air) well above the maximum level specified in the IEC61000-4-2 international standard without performance degradation.

Littelfuse Inc.
Website: www.littelfuse.com

Companion chip

The MB86R91 APIX companion chip enables the connection of modern high-performance ap-

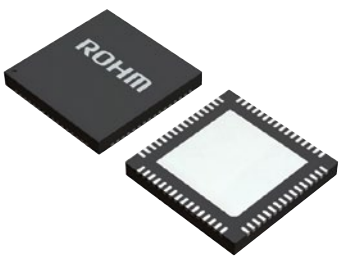
plication processors via various standard interfaces, such as single or dual OpenLDI flat panel display links and DRGB888. The fully-integrated high-speed APIX2 transmitters, with a downlink data rate of 3Gbps and an uplink rate of 187.5Mbps, allow up to three high-resolution remote displays to be connected in parallel.

Socionext Inc.

Website: www.socionext.com

Power management IC

ROHM recently announced the development of a high-efficiency power-management IC optimised



for Freescale Semiconductor's i.MX 6SoloLite applications processor.

ROHM's BD71805MWV utilises power supply technology cultivated for mobile applications to optimise circuit configuration for the i.MX 6SoloLite processor. The result is significantly reduced power consumption during both standby and normal operation, prolonging battery life considerably.

ROHM Co. Ltd

Website: www.rohm.com

Microcontroller

Renesas has announced the RL78/G1F group of multi-function microcontrollers (MCUs). Featuring enhanced peripheral functions and compatibility across the RL78/G1x series of MCUs, the new devices simplify sensorless brushless DC motor (BLDC motor) control and deliver precision operation at faster rotational speeds with high accuracy for energy-efficient home appliances and electric power tools.

Renesas Electronics Corp.

Website: www.renesas.com

System on chip

MediaTek Helio P10 is a high-performance, high-value system on chip focused on the growing demand for slim form factor smartphones that provide premium, flagship features. It showcases 2GHz, true octa-core 64-bit Cortex-A53 CPU and 700MHz, dual-core 64-bit Mali -T860 GPU.

MediaTek Inc.

Website: www.mediatek.com

Piezo switch

The PSE HI piezo switches from Schurter Electronics have an ingress protection class rating of IP67. The hermetic seal makes the switches ideal for use in areas that must be regularly cleaned or disinfected.

The switches offer a robust metal housing, well-suited for use in harsh environments. The impact resistance according to DIN EN 50102 is IK06.

SCHURTER Electronics (India) Pvt Ltd

Website: www.SCHURTER.co.in

Embedded flash memory

Microchip Technology, through its Silicon Storage Technology (SST) subsidiary, and GLOBALFOUNDRIES, has announced SST's 55nm embedded SuperFlash non-volatile memory (NVM) on GLOBALFOUNDRIES' 55nm Low Power Extended (LPx)/RF-enabled platform. The technology meets JEDEC standards and the requirements of AEC-Q100 grade I qualification with an ambient temperature range of -40°C to 125°C and endurance of 100k program/erase cycles with more than 20 years of data retention at 150°C.

Microchip Technology Inc.

Website: www.microchip.com

T&M

Oscilloscope

The deep memory digital storage oscilloscope from MetroQ has the following features:

Ultra-thin. Minimum 7cm

Super-light. 1.8kg

Storage depth. Maximum 10M

Display extension. SVGA output

LAN. Network data sharing

Metro Electronic Products

Website: www.metroQ.in

Digital clampmeter

MECO-G has introduced a new series of handheld 3½-digit clampmeters with back-light LCD display. These can measure AC voltages, DC voltages, AC current, resistance, capacitance, temperature and frequency.

Additional features like diode test, transistor check, continuity check, low battery display, data hold and auto power off are also available.

Goliya Instruments Pvt Ltd

Website: www.goliyainstruments.com

Radio communication analyser

The MT8821C radio communication analyser is designed for R&D of mobile devices/user equipment,

such as smartphones, tablets and M2M modules. It builds on the technologies of its popular predecessor, MT8820C, and supports all technologies, ranging from LTE-Advanced to 3G/2G, with its easy-to-use measurement functions for efficient radio frequency adjustment and testing in one unit.

Anritsu India Pvt Ltd

Website: www.anritsu.com

LEDs

LED streetlight

Pyrotech offers a complete range of energy-saving IP-66 certified LED super-mini streetlights with opti-

mum thermal management and highly efficient constant-current driver, having short-circuit and open-circuit protection in die-cast aluminium housing. With these lights, you can save up to 80 per cent power. The power factor is >0.9 and the housing is weather-proof.

Pyrotech Electronics Pvt Ltd
Website: www.pyrotechlighting.co

SOFTWARE

PCB designer

Allegro PCB Designer Manufacturing Option from Cadence Design Systems is a comprehensive, powerful, easy-to-use toolset that makes it efficient and cost-effective for PCB designers to streamline the development of a release-to-manufacturing package for their products. It includes the Design for Manufacturing (DFM) Checker, Documentation Editor and Panel Editor modules.

Cadence Design Systems Inc.
Website: www.cadence.com

MCAD co-designer

Altium has released a new extension for its flagship PCB design tool, Altium Designer. MCAD Co-Designer: SOLIDWORKS helps to facilitate collaboration between mechanical and electronic design teams with integrated design data, a managed change environment for design revisions and lifecycle management for component creation, among other features.

Altium Ltd
Website: www.altium.com

MISCELLANEOUS

IoT edge node

Round Solutions has launched its wireless PingPong IoT edge node, a flexible and powerful hardware platform for connecting field devices to the cloud.

The PingPong hardware platform offers high-speed mobile modules for the IoT connectivity as well as numerous interfaces to the field, which can also be controlled via the cloud.

Round Solutions GmbH & Co. KG
Website: www.roundsolutions.com

Fluxing and soldering system

The IS-T-300 from Manncorp is an all-in-one selective fluxing and soldering system, designed to deliver high quality and consistent, efficient performance. IS-T-300 comes fully-equipped with advanced features like high-precision drop-jet fluxing, laser-controlled wave-height compensation and CAD data import.

Manncorp
Website: www.manncorp.com

Galvanic skin response system

Wearables developers can now evaluate galvanic skin response (GSR) sensing with MAXREFDES73# reference design from Maxim Integrated.

Its key advantages are:

Fast time-to-market. Integrates DAC and ADC signal chain components, low-power MCU, external Bluetooth and Android apps and firmware components to quickly develop and test designs

High accuracy. 16-bit integrated analogue front-end (AFE)

Low power consumption. Operates for one week on one battery charge

Maxim Integrated Products Inc.
Website: www.maximintegrated.com

VoIP-GSM gateway

Matrix SETU VG is a compact VoIP-GSM gateway with up to 4/8 GSM and 3G SIM support. Integrated GSM/3G connectivity and open-standard SIP support enables SETU VG gateway to easily connect with leading IP phone systems, software based IP-PBXs, hosted and SIP trunking services.

It also delivers value added features such as hot swapping of SIM cards, remote SIM balance inquiry and

recharge, automatic number translation, configurable call minutes, SMS notifications, monitoring and auto provisioning for mass deployments.

Matrix Comsec
Website: www.matrixtelesol.com

Ultra-HD monitor

The VP2780-4K offers an ultra-high 3840 × 2160 4K UHD resolution. The SuperClear IPS display technology provides consistent and true-to-life images from any viewing angle. It delivers the ultimate colour performance with 100 per cent sRGB colour coverage.

The VP2780-4K has 10-bit colour, 14-bit processing, 3D LUT and Delta E≤2 colour accuracy, which renders the image on display and printout as accurately as it is on camera. Each display is individually calibrated and manually adjusted for greater colour accuracy as part of the production process to ensure perfect image quality.

ViewSonic Corp.
Website: www.viewsonic.com

Controller

Serving as a cost-effective alternative to a PLC, the controller provides 40 digital inputs along with 12 analogue inputs. There are a total of 30 relay outputs, along with two SSR outputs. Analogue output ports include two PWM ports and two standard 4mA-20mA output ports. The controller unit comprises a digitally-calibrated 14.5cm (5.7-inch) TFT display.

Godrej & Boyce Mfg. Ltd
Website: www.godrej-iea.com

Arduino Based Gesture-Controlled Robot

PRASHANT KUMAR

Presented here is an Arduino based gesture-controlled robot, which is controlled through an accelerometer module using wireless radio frequency (RF) communication.

Circuit and working

In this project, we have used two Arduino UNO boards, one at the transmitter side as shown in Fig. 1 and the other at the receiver side as shown in Fig. 2. The transmitter circuit is attached to the hand and the receiver circuit is attached to mechanical chassis of the robot.

Hand gestures, as shown in Fig. 3, can control the robot using an accelerometer such as ADXL345 module. By changing the axis of ADXL345, we get corresponding changes in X-axis, Y-axis and Z-axis coordinates. These are sent to Arduino Board2 and, accordingly, control

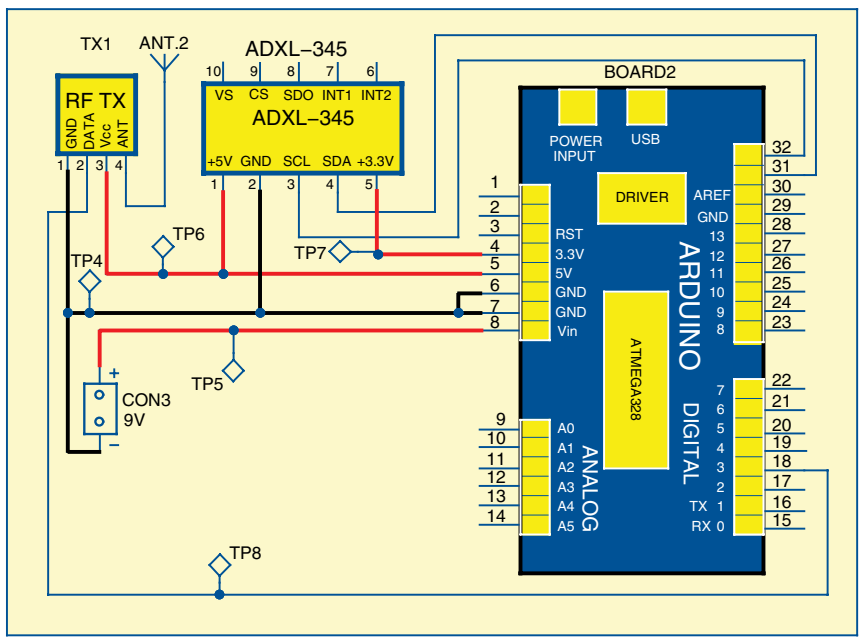


Fig. 1: Transmitter-side circuit

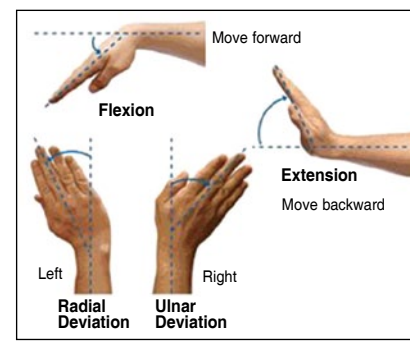


Fig. 3: Various hand gestures

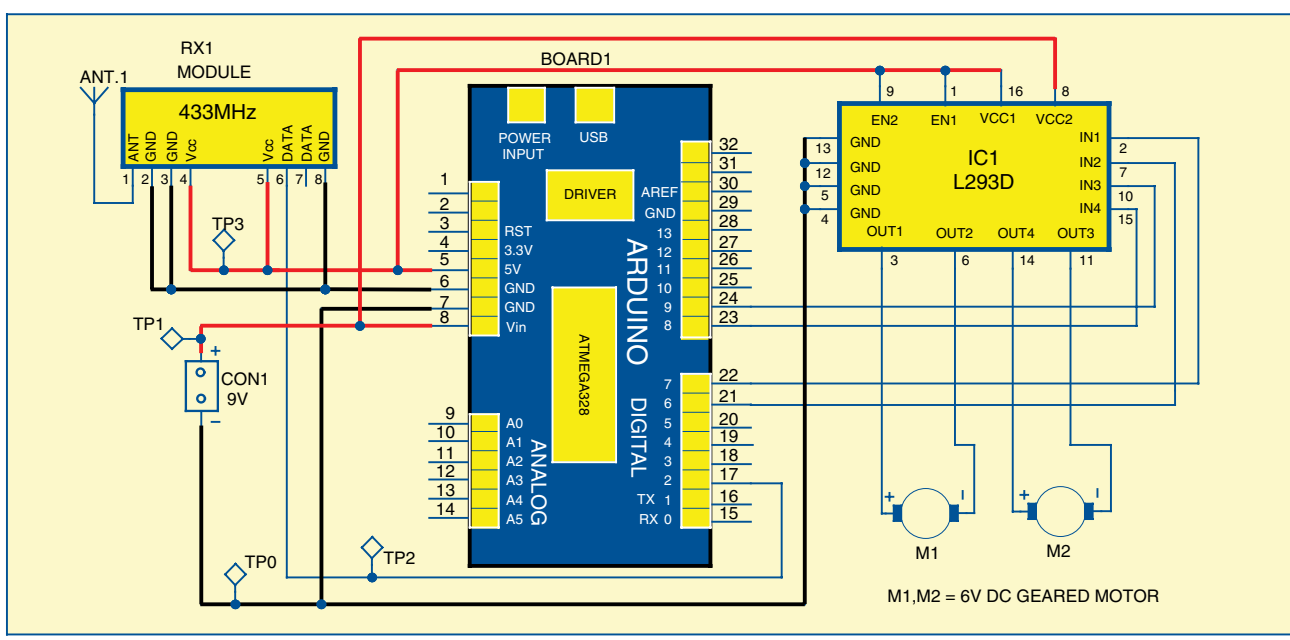


Fig. 2: Receiver-side circuit

Test Points

Test point	Details
TP0, TP4	0V (GND)
TP1, TP5	9V DC
TP2, TP8	Data
TP3, TP6	5V DC
TP7	3.3V DC

command to the robot is sent through the RF transmitter module wirelessly.

These transmitted signals are received at the receiver end through an RF receiver module and transferred to Arduino Board1 at the receiving end, which then drives L293D IC to rotate the motors for robotic movement.

Arduino UNO board. Arduino UNO is an open source electronics prototyping platform based on flexible, easy-to-use hardware and software. Arduino UNO development board is built around ATmega328 chip. It has 14 digital input/output pins [of which six can be used as pulse-width modulation (PWM) outputs], six analogue inputs, a 16MHz ceramic resonator, USB connection, power jack, an ICSP header and reset button. It contains everything for supporting the microcontroller (MCU); simply connect it to a computer with a USB cable or power it with an AC-to-DC adaptor or battery to get started.

ADXL345 module. ADXL345 accelerometer modules are available from various manufacturers. Shapes and sizes of the modules may differ but these all have SDA, SCL, SDO and CS pins for I2C and ISP serial communications. Pin details of a typical ADXL345 module are shown in Fig. 4.

You may also use a module equivalent to ADXL345 such as Keyes-345 accelerometer module. It communicates with Arduino using I2C communication protocol. Here, Arduino UNO board acts as the master device and ADXL345 as the slave device. SDA and SCL pins of ADXL345 should be connected to the SDA pin (pin 31) and SCL pin (pin 32) on Arduino UNO board, respectively.

Fig. 4: Pin details of a typical ADXL345 module

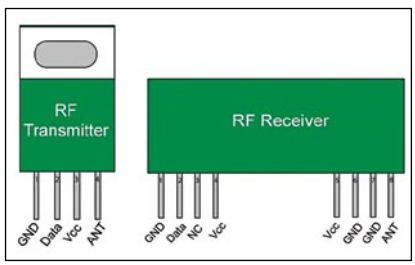


Fig. 5: RF transmitter and receiver modules

Readings of the accelerometer will give the tilt direction of ADXL345 on all three axes (X, Y and Z) by varying the gesture of the hand.

RF module. An RF module is a fast and effective device for wireless communication for shorter ranges. Here, we have used a pair of RF transmitter and receiver modules, operating at 433MHz. A library of Arduino, named VirtualWire.h, is used to sync the RF module with Arduino. Of the eight pins of the RF receiver, only four pins, namely, Antenna, 5V, GND and Data are used here. Connect a single-strand wire to Antenna pin of both transmitter and receiver pins of the RF modules as shown in Fig. 5.

Software program

Program for this robot includes Wire.h header file for I2C communication protocol and VirtualWire.h library of Arduino to sync the RF module with Arduino.

VirtualWire.h is an Arduino library that provides features to send short messages. It allows you to send and receive data bytes and strings easily.

The software has the following functions:

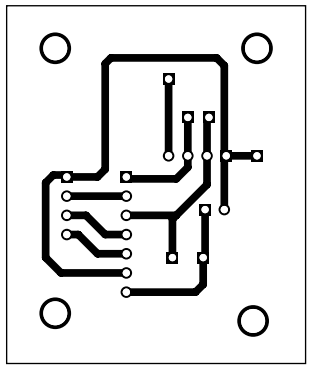


Fig. 6: Actual-size PCB layout of the transmitter circuit

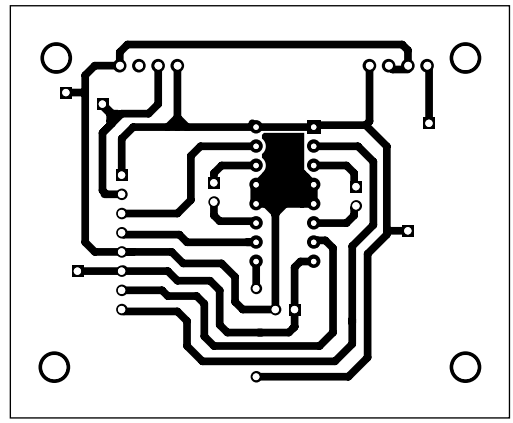


Fig. 8: Actual-size PCB layout of the receiver circuit

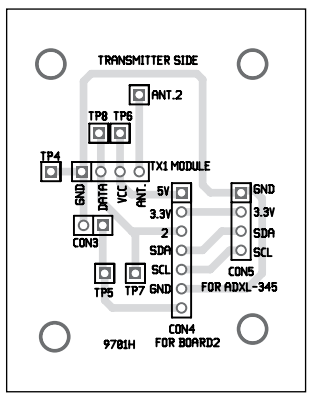


Fig. 7: Component layout of the transmitter circuit

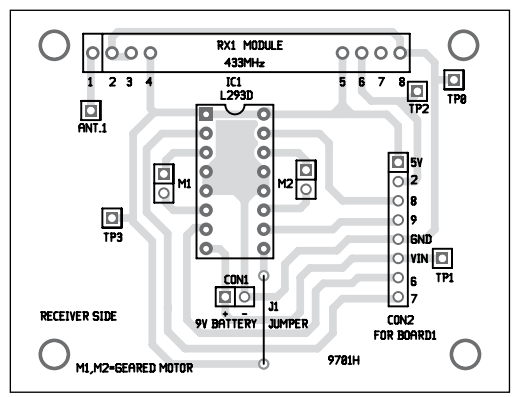


Fig. 9: Component layout of the receiver circuit

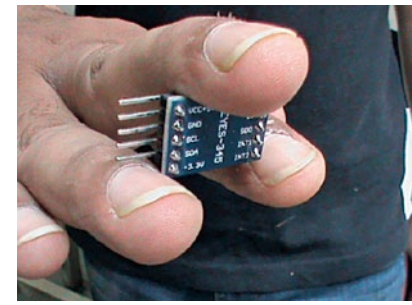


Fig. 10: Attaching the accelerometer module between fingers

PARTS LIST

Semiconductors:	
LCD1	- 16×2 LCD
IC1	- L293D motor driver
BOARD1, BOARD2	- Arduino UNO board
TX1	- 433MHz RF transmitter module
RX1	- 433MHz RF receiver module
ADXL345	- Accelerometer module
Miscellaneous:	
M1, M2	- 6V, DC geared motors
CON1, CON3	- 2-pin connector
CON2	- 8-pin connector
CON4	- 7-pin connector
CON5	- 4-pin connector
ANT.1, ANT.2	- 30cm-long single-strand wire antenna
	- USB A-B cable
	- 9V battery (2)

EFY Note

The source codes of this project are included in this month's EFY DVD and are also available for free download at *source.efymag.com*

void writeTo(int device, byte address, byte val). This function is used to write bytes of data from a particular byte address to the slave device.

void readFrom(int device, byte address, int num, byte buff[]). This function is used to read bytes of data of particular buff sizes from a specific buffer address.

void setup(). This function is used to initialise the baud rate for serial communication and other pins for digital input/output.

void loop(). This function is used to perform the required task of comparing data with the reference set by the user for X, Y and Z axes and perform the task of transmitting data for forward, backward, left and right movement of the robot.

Construction and testing

An actual-size, single-side PCB layout of the transmitter circuit for the hand-gesture-controlled robot is shown in Fig. 6 and its component layout in Fig. 7. An actual-size, single-side PCB layout of the receiver circuit is shown in Fig. 8 and its component layout in Fig. 9. Connect Board1 to CON2 in the PCB layout (Fig. 9), Board2 to CON4 and ADXL-345 to CON5 in the PCB layout (Fig. 7). Pin numbers shown in CON2 and CON4 refer to the digital pins of Arduino boards.

Fit the transmitter circuit in a glove so that it can be used repeatedly. Place ADXL345 below the middle finger such that the pins' side of ADXL345 is facing towards you as shown in Fig. 10. We use the middle finger for attaching ADXL345 because it will get the best average motion of the movement of the hand.

The rest of the circuit of Arduino and RF transmitter can be fitted near your wrist or on a separate PCB so that it does not disturb hand movements.

On the receiver side of the robot, Arduino UNO board should be connected to L293D IC and the remaining circuit through proper connection of wires. We have used standard 9V batteries to power transmitter and receiver circuits during testing. Use of separate voltage sources for Arduino UNO board and L293D motor driver IC is recommended for better performance. A 30cm-long wire can be attached to antenna pins of both transmitter and receiver modules for better communication. ●

Prashant Kumar is a B.Tech from IIT, Jodhpur. His interests include working with robotics, circuit design and Arduino boards

Android Application for an RC Charging and Discharging Circuit

K. BASKAR

An RC circuit is an electric circuit consisting of a resistor and a capacitor. This article describes the simple RC charging and discharging circuit with an Android application as shown in Fig. 1. By using this Android application, you can calculate capacitor charging and discharging voltages and currents, and capacitor charging and discharging times with graphical outputs. The program is written in Java programming language. Achartengine-1.1.0 graph library is used to simulate the graph output.

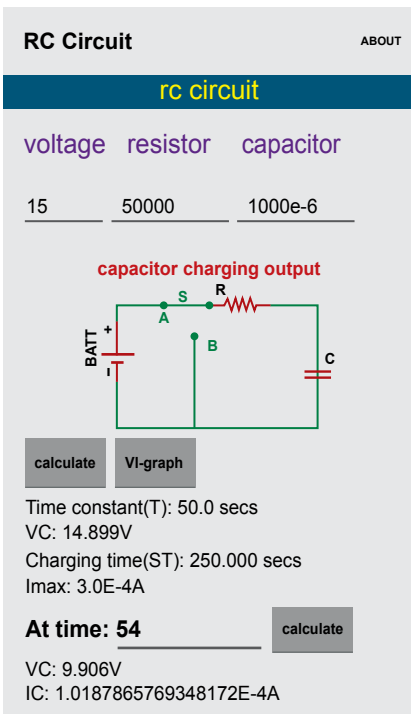


Fig. 1: RC Android application

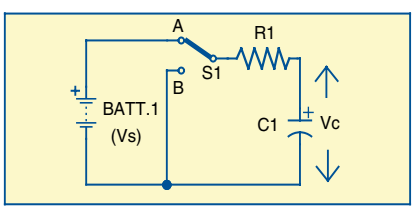


Fig. 2: Capacitor charging circuit

RC charging circuit

The RC charging circuit is shown in Fig. 2. In this circuit, the resistor and capacitor are connected across the battery through mechanical switch S1. When switch S1 is closed, current from the battery passes through the resistor and, gradually, charges the capacitor until the capacitor voltage equals battery voltage (Vc = Vs).

At time t = 0, the voltage gradually builds up across the capacitor as shown in Fig. 3 and the current gradually decreases due to decrease in movement of electrons as shown in Fig. 3. The rate of charging is described in terms of time constant, denoted by $\tau = R \times C = R1 \times C1$. In the application, Vc is capacitor voltage, Imax is maximum current in the capacitor and Ic is capacitor current.

Formulae to calculate various parameters are given in the box.

For time $t = 1\tau$ (one time constant), $Vc = Vs(1-e^{-1}) = 0.63Vs$

That is, the capacitor has been charged to 63 per cent of its final value. After 5τ (or five times constant), the capacitor will be fully charged.

For example,

If R1 = R = 50k-ohms, Vs = 15V, C1 = C = 1000µF, time constant $\tau = 50k \times 1000e^{-6} = 50.0$ seconds as shown in Fig. 1.

For time $t = 5\tau$, capacitor is fully charged. We need to calculate 5τ to know charging time t of the capacitor.

Using the formula given in the box, time $t = 5(50k \times 1000e^{-6}) = 250$ seconds, we get Vc = 14.899V, Imax = 0.003A and Ic = 2.0213µA

At t = 54 seconds, Vc = 9.906V and $Ic = 1.0187865e^{-4}$

RC charging output graph in the Android application for the example is shown in Fig. 4.

In the output graph, the white line indicates the gradual decrease in current across the capacitor, and the yellow line indicates the gradual increase in voltage across the capacitor. This output waveform has one X axis and two Y axes. Left-side Y axis indicates the capacitor current

Calculation of various parameters

Time constant $\tau = R \times C$

Where τ = time constant, R = R1 = resistor and C = C1 = capacitor

Voltage across the charging capacitor $Vc = Vs(1-e^{-t/RC})$

Where Vc = voltage across the charging capacitor, Vs = supply voltage, t = elapsed time

Voltage across the discharging capacitor $Vc = Vs(e^{-t/RC})$

RC = Time constant of the charging circuit

Current through the capacitor $Ic = \frac{Vs}{R} e^{-t/RC}$

Maximum current in the capacitor $Imax = \frac{Vs}{R}$

Where Ic = current through the capacitor, R = resistor, t = elapsed time and RC = time constant of the charging circuit

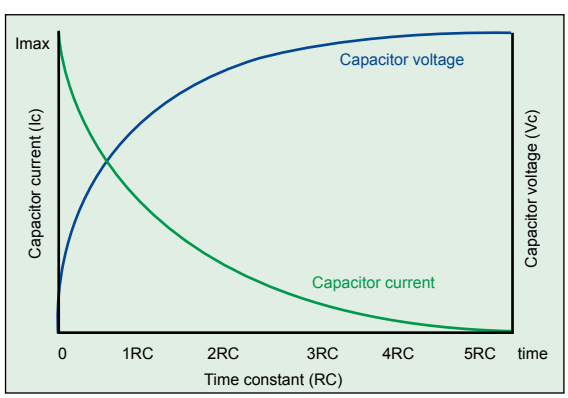


Fig. 3: A typical capacitor charging output graph

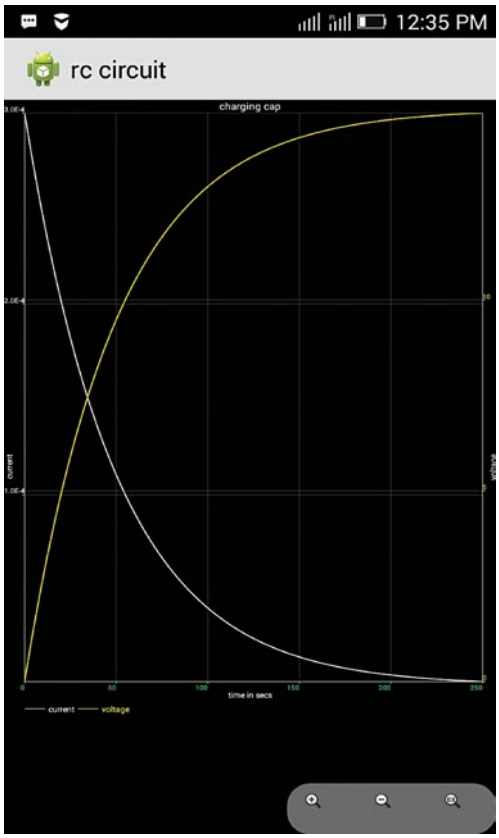


Fig. 4: Charging capacitor output graph on Android

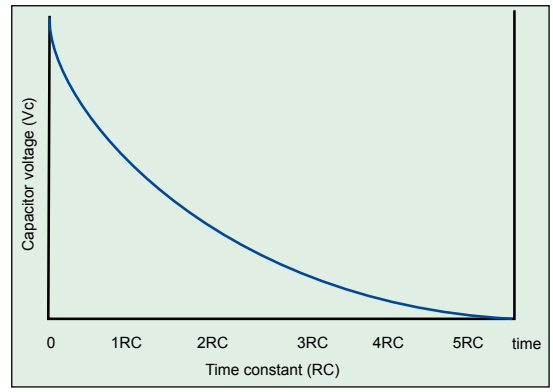


Fig. 6: Capacitor discharging voltage graph

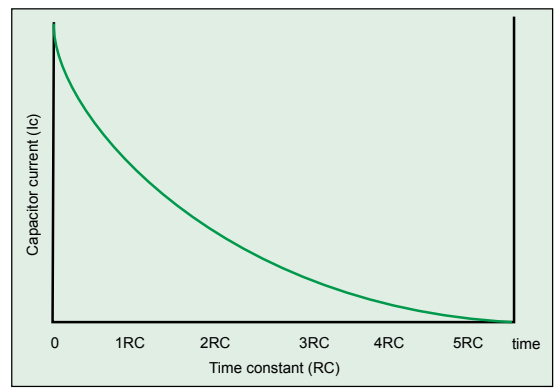


Fig. 7: Capacitor discharging current graph

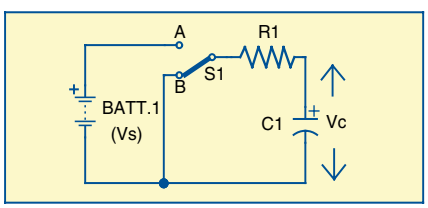


Fig. 5: Capacitor discharging circuit

and the right-side Y axis denotes the capacitor voltage. X axis indicates the charging time of the capacitor or time constant of the capacitor.

RC discharging circuit

In the discharging circuit, mechanical switch S1 is turned to position B and the battery is left open as shown in Fig. 5. During this time, the charge stored in the capacitor starts to discharge through resistor R1 until charge in the capacitor equals zero (Q = 0).

From Fig. 6, at time t = 0, Vc gradually decreases because accumulation of the positive charge and the negative charge freely moves away from the plates of the capacitor. So, the potential difference between the plates decreases.

As shown in Fig. 7, from time t = 0, current across the capacitor gradually decreases. In other words, at t = 0, the battery is disconnected. So, stored electrostatic charges tend to freely move from the plates through the resistor. Therefore voltage (potential difference between two plates) across the two plates decreases. In the discharging circuit, both voltage and current gradually decrease.

Voltage across the capacitor and current in the capacitor are calculated using the formulae given in the box.

Time constant of the discharging capacitor is calculated using:

$\tau = R \times C = R1 \times C1 = 50k \times 1000e^{-6}$
$= 50$ seconds

For time $t = 5\tau$ (five times constant), the capacitor is fully charged. So, we need to calculate 5τ to know the discharging time of the capacitor; time $t = 5(50k \times 1000\mu) = 250$ seconds.

Capacitor maximum current Imax = 0.003A

Voltage across the discharging capacitor is calculated using:

At time t = 0, capacitor voltage = 15V; after 250 seconds, the capacitor has almost zero voltage:

$Vc = Vs(e^{-t/RC})$

$= 15(e^{\frac{-250}{(50k \times 1000\mu)}})$

$= 0.101V$

Current across the discharging capacitor Ic = 2.0213µA

At 54 seconds, the capacitor discharging voltage and capacitor discharging current are:

$Vc = 5.093V$ and $Ic = 1.0187865e^{-4}$

Voltage and current graphs of a discharging capacitor on Android are shown in Figs 8 and 9, respectively.

Development of Android application

First, you need to install Java Development Kit (JDK) version 1.7.0 or above on your Windows computer. We have tested this on Windows 8.1, 64-bit. Configuration of JDK is included in this month's EFY DVD accompanying EFY Plus magazine.

Next, you need to install Android Studio version 1.1.0. Details for setting up Android Studio, configuration of Software Development Kit (SDK) manager and Android Virtual Device have been included in the DVD.

Importing the Android project. To import the Android project, click file tab→Import as shown in the Fig. 10.

Click Android→Existing Android Code into Workspace as shown in Fig. 11.

Click Browse and navigate your Android project (rcckt1). Click OK as shown in Fig. 12.

Program compilation. Click Android project folder; right-click on src folder→select run→. Click Run as Android application and select your phone from the dialog box or select the An-

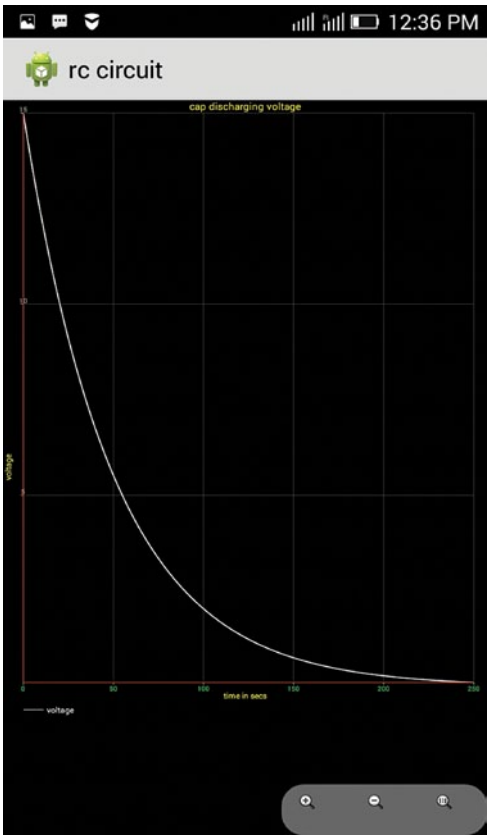


Fig. 8: Capacitor discharging voltage graph

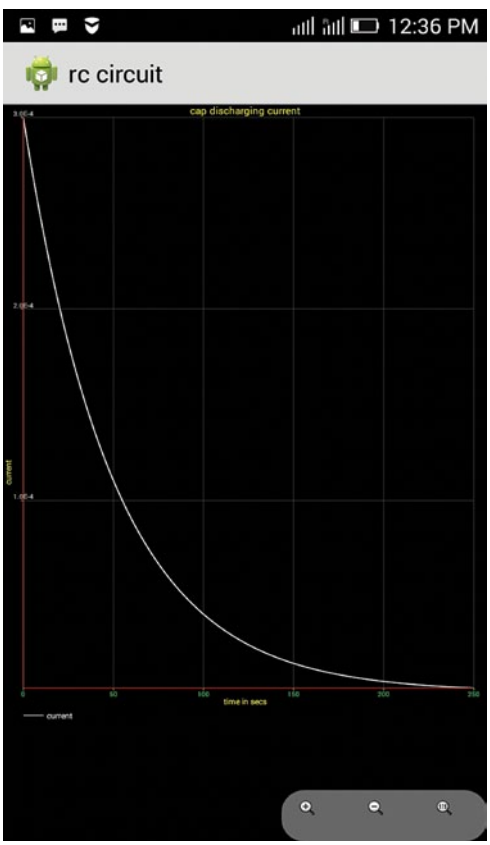


Fig. 9: Capacitor discharging current graph

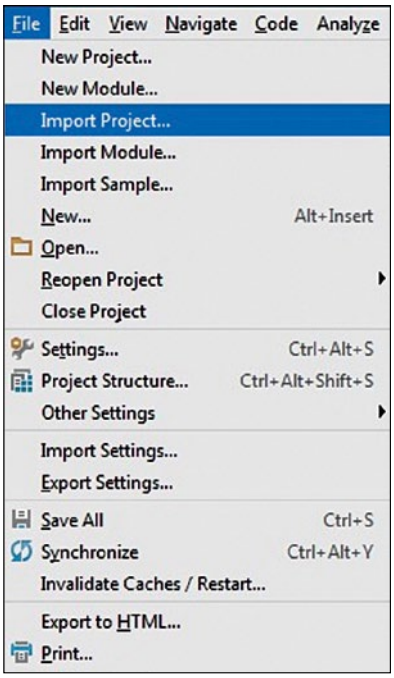


Fig. 10: Importing the project

Fig. 11: Selecting the existing code

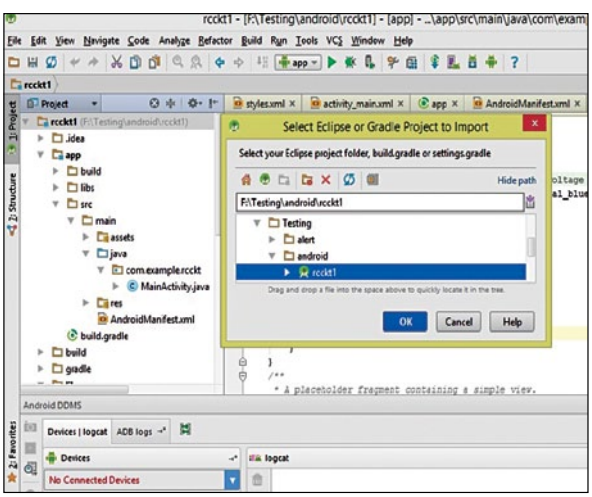


Fig. 12: Selecting directory

EFY Note

The source code of this project is included in this month's EFY DVD and is also available for free download at *source.efymag.com*

droid emulator that you have created. To run the emulator, you need to install Intel x86 emulator accelerator (HAXM installer) from SDK manager.

Compile the program by clicking Rebuild Project under Build menu. Once it is compiled successfully, you can connect your Android phone to your computer. Before connecting, select USB Debugging under Developer Options on your device. After connecting, you will see the mobile device model on the bottom-left side of the screen. Run the application by selecting Run app under Run menu. You can see the app on your Android device. This app is tested on 4.1.2 Jelly Bean and 4.4 Kitkat Android operating systems.

By now your app would have transferred to your Android phone, so you can disconnect from the computer and run the app. app-debug.apk is automatically generated under rcckt1/app/build/apk folder. Copy and transfer this apk file to another Android device.

apk installer software is available in almost all latest Android smartphones. So, you can install it to run it. To publish the app on Google Play Store, you should select Generate Signed APK... under Build menu.

Minimum required operating system is Android 3.0 Honeycomb (API level 11), and it works up to Android 5.0 Lollipop (API level 21). ●

K. Baskar is ME from J.J. College of Engineering, Tiruchirappalli. He is working as software developer at Netsec Solution, Chennai. His interests include space science, computer programming and digital art

Electronic Door Lock Using Arduino

JOY MUKHERJI

Presented here is an electronic locking system in which Arduino Nano plays the role of the processing unit. This circuit allows activation of an electronic door lock only on entering the correct password. It uses Arduino Nano to provide a keypad interface door lock for the front door.

It is a keyless system where you can use your own personal code to enter your home with just a few simple pushes of some buttons. The keypad lock functions by entering a secret code, which is user-programmable. Prototype of the electronic door lock is shown in Fig. 1.

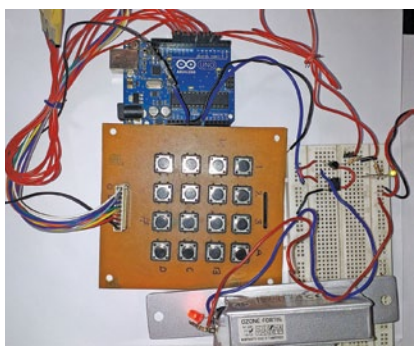


Fig. 1: Prototype of the electronic door lock using Arduino

Circuit and working

Using a microcontroller (MCU) cuts down on external components. The circuit comprises Arduino Nano board, transistors PN2222A (T1) and BD139 (T2), a 4x4 matrix keypad (S1-S16), solenoid lock and a few other components. The 4x4 matrix keypad is connected to Arduino digital pins D5 through D12. The keypad is simply an arrangement of 16 push-button switches in a 4x4 matrix form.

Typically, a hex keypad will have keys for numbers 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9, letters A, B, C and D, and symbols * and #. The hex keypad will have eight connection wires, through resistors R1, R2, R3, R4 and capacitors C1, C2, C3, C4, representing the rows and columns, respectively.

The matrix-encoding scheme requires fewer output pins and, thus, fewer connections that have to be made for the keypad to work. The schematic diagram of the electronic door lock system is shown in Fig. 2.

Arduino receives parallel data from the keypad. Arduino software constantly scans the keypad to see if a button is pressed. Upon receiving a valid code input, digital pin D4 goes high and fires up the solenoid lock for five seconds. Transistor T2 is capable of supplying up to 1.5 ampere current to the solenoid. LED1 indicates that the lock has been opened. Entering an invalid code causes it to blink a few times. Diode D5 protects the circuit from any back EMF that might be created when the lock is turned off.

Test Points

Test point	Details
TP0	0V (GND)
TP1	5V
TP2	12V

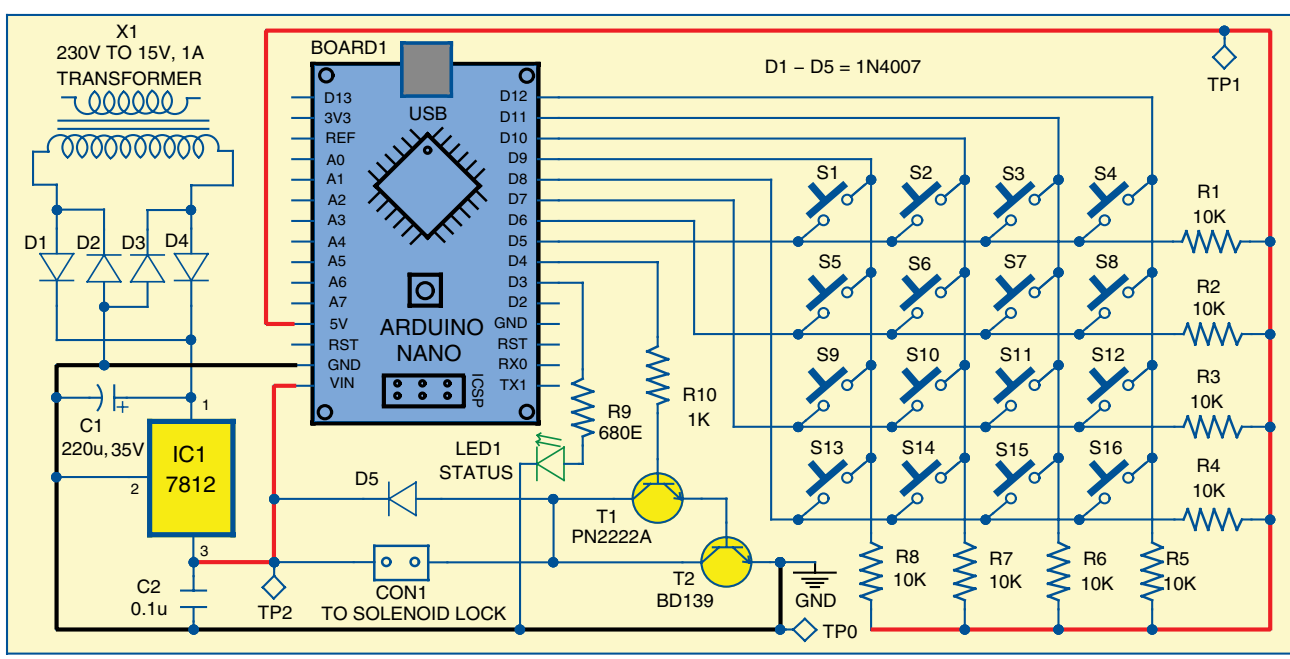


Fig. 2: Schematic diagram of the electronic door lock system

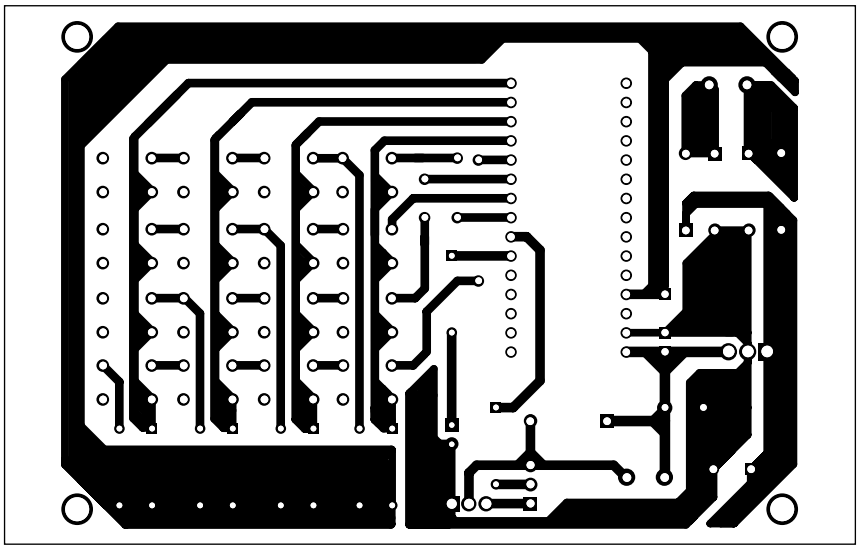


Fig. 3: Actual-size PCB layout of the electronic door lock system

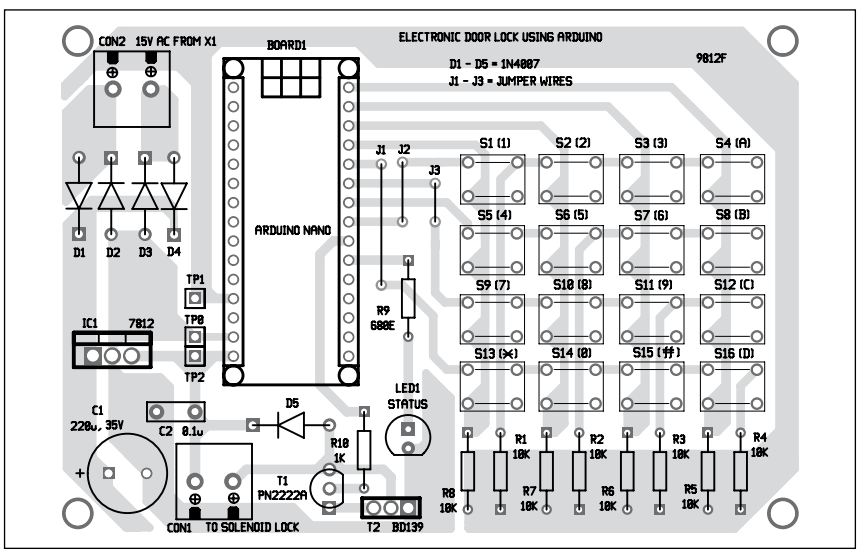


Fig. 4: Component layout of the PCB

Software

The software code (door lock.ino) for Arduino Nano is written in Arduino programming language and compiled using Arduino IDE.

keypad.h header file is added to the library for the functioning of the keypad. This library can be downloaded from *http://playground.arduino.cc/code/Keypad#Download*

After downloading, import this library to Arduino IDE from Sketch- > Import Library...- > Add Library option.

The default password is *1234# that can be modified by making changes to the code in the following line:

char PIN[4] = {'1','2','3','4'}

Construction and testing

Any Arduino-Nano- or UNO-compatible board can be used for this project. However, Arduino Nano is recommended as it is small and compact. It accepts 6V DC to 20V DC external power supply. Use of a 230V AC primary to 15V, 1A secondary transformer (X1) is recommended. Here we have used a regulated supply circuitry using 12V regulator IC 7812 to drive the circuit and solenoid lock.

An actual-size, single-side PCB layout of the electronic door lock system is shown in Fig. 3 and its component layout in Fig. 4. You can also use a readymade keypad module in place of the switches S1 through S16 given in this PCB. Readymade keypad interfacing with Arduino is shown in Fig. 5.

PARTS LIST

Semiconductors:

BOARD1	- Arduino Nano board
IC1	- 7812, 12V regulator
LED1	- 5mm LED
T1	- PN2222A npn transistor
T2	- BD139 npn transistor
D1-D5	- 1N4007 rectifier diode

Resistors (all 1/4-watt, ±5% carbon):

R1-R8	- 10-kilo-ohm
R9	- 680-ohm
R10	- 1-kilo-ohm

Capacitors:

C1	- 220µF, 35V electrolytic
C2	- 0.1µF ceramic disk

Miscellaneous:

X1	- 230V AC primary to 15V, 1A secondary transformer
S1-S16	- 4×4 matrix keypad using tactile switches
CON1, CON2	- 2-pin connector terminal
	- 12V solenoid lock

EFY Note

The source code of this project is included in this month's EFY DVD and is also available for free download at *source.efymag.com*

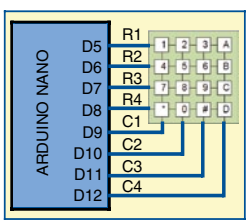


Fig. 5: 4x4 matrix keypad

Connect transformer X1 to the PCB at CON2 (Fig. 4). Initially, the solenoid lock (connected on CON1) will be locked and the status LED (LED1) connected on digital pin D3 of Arduino will be off.

When the user enters the right password, the solenoid lock gets unlocked for five seconds and LED1 glows. After five seconds, both LED1 and solenoid lock will be in the initial off state.

If the password is incorrect, LED1 will blink a few times, indicating that a wrong password has been entered.

The different voltage levels of 12V (TP2) and 5V (TP1) can be measured with respect to 0V (TP0), as listed in the table.

Joy Mukherji is an electronics hobbyist and a small-business owner in Albany, New York, the USA. His interests include designing radio frequency (RF) circuits

See and Speak Using Raspberry Pi

GURUNATH REDDY M.

Imagine a machine that can see and speak, and is fully portable. It is surprising, right? In this article, we present a system based on Raspberry Pi, or Raspi, that can see and speak. It takes pictures of text content around its vicinity from the webcam attached to Raspi, converts it to speech and speaks out the text through a headphone or speaker connected to its audio jack.

This portable device can be used in many applications in robotics, automation, hobby projects and more. For example, you can focus your webcam to a text, such as English alphabets, on a signboard, followed by pressing a pushbutton switch connected to Raspi. It will capture the text and convert it to speech and read it out aloud to you. When you get bored of reading books, just click a picture of the textbook page and make it read the same aloud to you.

Circuit and working

The system uses a webcam, Raspi and pushbutton switch S1 to take pictures as shown in the block diagram in Fig. 1 and the circuit diagram in Fig. 2.

The webcam (we used Logitech C270) is connected to Raspi through one of its USB ports and pushbutton switch S1 to its GPIO pin 16 (or GPIO23) through resistor R2 (1-kilo-ohm) as shown in the circuit diagram.

First, focus the webcam manually towards the text. Then, to take a picture, press pushbutton switch S1. A delay of around ten seconds is provided, which helps to focus the webcam if you accidentally disturb the webcam and defocus it while pressing the button.

After ten seconds, a picture is taken and processed by Raspi to provide the spoken words of the text through the earphone or speaker plugged into Raspi through its audio jack.

When the GPIO pin is set as input, it is floating and has no defined voltage level. For you to be able to reliably detect whether the input is high or low, you need to have some simple resistive circuit so that it is always connected and reads either high or low voltage.

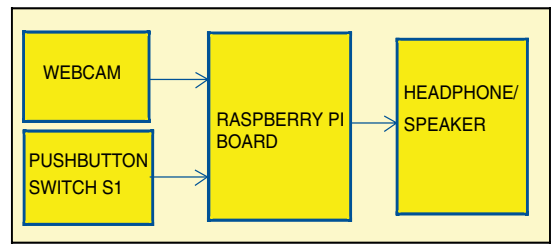


Fig. 1: Block diagram of the See and Speak system

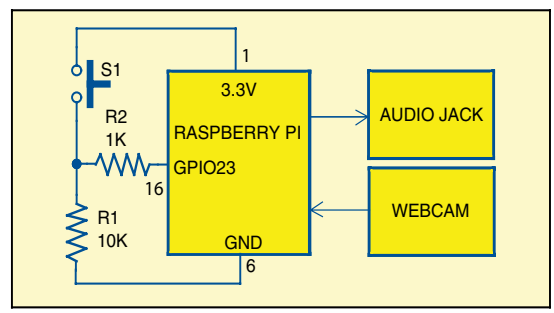


Fig. 2: Circuit connection to Raspi board

One of the terminals of switch S1 is connected to ground (GPIO pin 6) through pull-down resistor R1 of 10-kilo-ohm. The other terminal is connected to 3.3V of GPIO pin 1.

When S1 is pressed, a high voltage is read on GPIO pin 16. When S1 is released, GPIO pin 16 is connected to ground through R1, hence a low voltage is read by GPIO pin 16.

When pushbutton S1 is pressed, the webcam takes a picture of the text (after some delay). This text picture is sent to an optical character recognition (OCR) module such as Tesseract. Tesseract is an open source OCR that can be used to recognise the text present in the image. It supports many languages. Here, we have used it for English alphabets.

Before feeding the image to the OCR, it is converted to a binary image to increase the recognition accuracy (to check if the image is coloured). Image binary conversion is done by using Imagemagick software, which is another open source tool for image manipulation.

The output of OCR is the text, which is stored in a file (speech.txt). Here, Festival software is used to convert the text to speech. Festival is an open source text-to-speech (TTS) system, which is available in many languages; in this project, English TTS system is used for reading the text.

Software installation

Update and upgrade Raspi-related software using the commands below and reboot your Raspi:

```
$ sudo apt-get update
$ sudo apt-get upgrade
```

Install Tessarat OCR system by issuing following command:

```
$ sudo apt-get -s install tesseract-ocr
```

Install image-manipulation tool Imagemagick using the command:

```
$ sudo apt-get install imagemagick
```

Install fswebcam to get pictures from the webcam using the command:

```
$ sudo apt-get install fswebcam
```

To check whether the webcam is installed properly, issue the command:

```
$ fswebcam example.jpg
```

An image by the name example.jpg will get saved in the home directory. If the resolution of this image is not up to the mark, change it by using -r option in fswebcam. One example of 1280x720 resolution capturing is shown below. Set this according to your webcam.

```
$ fswebcam -r 1280x720 example.jpg
```

To install sound on Raspi, install alsa sound utilities using the command below:

```
$ sudo apt-get install alsa-utils
```

Edit the modules file at /etc/modules using nano editor.

```
$ sudo nano /etc/modules
```

Add the line snd_bcm2835. If snd_bcm2835 is already present, leave the file as it is.

Then, save the file by clicking ctrl + o and exit with ctrl + x.

Now, install mplayer audio movie player using the command:

```
$ sudo apt-get install mplayer
```

Once you have completed all the steps mentioned above, install Festival text-to-speech software using the command:

```
$ sudo apt-get install festival
```

You may try Festival installation using the command below in the terminal and you will hear Hello EFY in the earphones.

```
$ echo "Hello EFY" | festival --tts
```

Once all the above software are installed, copy see.py Python code, which is included in this month's DVD available with Electronics For You Plus version of the magazine in Home folder.

Run see.py by issuing the following command:

```
$sudo python see.py
```

see.py runs indefinitely to get input from the user.

Note. If the resolution of your camera is not good, OCR performance will be poor and the speech output will also degrade.

We have used Logitech C270 camera for testing this project. The camera resolution by default is 720x340, which is the maximum resolution supported by this webcam. If the camera is unable to capture the text properly, you will either hear distorted sounds from the speaker or no sound at all.

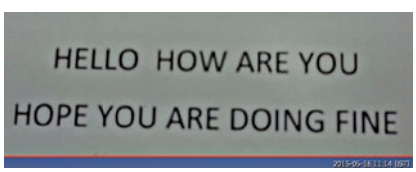


Fig. 3: Text image (example.jpg) captured by the camera during testing

EFY Note

The source code of this project is included in this month's EFY DVD and is also available for free download at *source.efymag.com*

The text image (example.jpg) being captured by this camera during testing is shown in Fig. 3. You can find example.jpg and speech.txt files under Home directory. ●

Gurunath Reddy M. is an MS student at IIT Kharagpur

Daytime Running Lights Controller

T.K. HAREENDRAN

Auto makers have been gradually switching to light emitting diode (LED) lighting for automotive headlamps because of its features such as high efficiency and long service life. In addition, from a safety perspective, applications of LED-driven daylight/daytime running lights (DRLs) for vehicles are spreading in many states.

The purpose of the circuit presented here is to activate DRLs on any lighting that uses LED and/or incandescent bulb in a vehicle. Before attempting to construct this circuit, remember that, you cannot directly hook up the circuit to any circuit that is controlled by the CANbus system in a vehicle. For example, if the parking lights of your vehicle are CANbus-controlled, the DRL circuit cannot be plugged to the parking-light circuit for DRL function.

But, if the fog-light circuit is not controlled by CANbus, then you can connect the DRL circuit to it. Author's prototype is shown in Fig. 1.

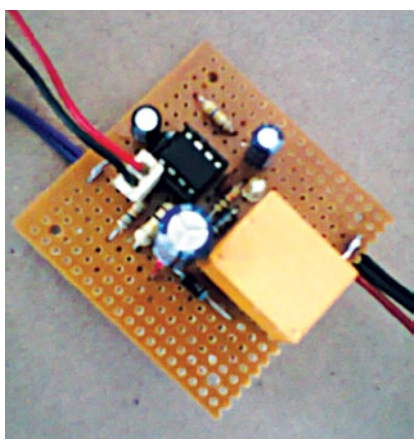


Fig. 1: Author's prototype

Circuit and working

Fig. 2 shows the circuit diagram of the DRL controller. It is built around timer NE555 (IC1), MOSFET 60NF06 (IRF1), 12V, 1C/O relay (RL1), DRLs and a few other components.

There are seven wires that come out of the circuit. The first connection (DRL-B and DRL-G) you will make is to the DRLs. These are the main wires that will make the bumper DRLs turn on when you start the vehicle (these will light up at start).

Connect DRL-B and DRL-G wires from the circuit directly to the DRLs at the bumper. The circuit activates when it senses ignition voltage. It does so by getting a signal from the main wire (IGN+) and the positive supply wire that runs from the circuit to the ignition-switched +12V power line. GND is main ground connection, and it must be connected directly to the negative battery (0V) terminal or the body of the vehicle.

Wiring Guide Table

Signal	Remarks
DRL-G	Negative (0V) of daytime running light
DRL-B	Positive (12V) of daytime running light
IGN+	Positive (12V) supply from ignition switch
HL+	Positive (12V) supply from headlight wiring
PL+	Positive (12V) supply from parking-light wiring
PB+	Positive (12V) supply from parking-brake/hand-brake wiring
GND	Common ground (0V) connection/vehicle body

You might have to extend the wire, if it does not reach the battery, by running sufficient length of the automotive wire from the circuit to the negative terminal of the battery. If you want the DRLs to switch off when you turn your headlights and/or parking lights on, connect HL+ and PL+ to the existing headlight and parking-light wires, respectively.

Wire connection PB+ is optional; you do not have to connect it unless you want the DRLs to work with the parking brake (hand brake). The potmeter (VR1) can be used to adjust the brightness of DRLs as per requirement. Note that, you can modify the circuit's default

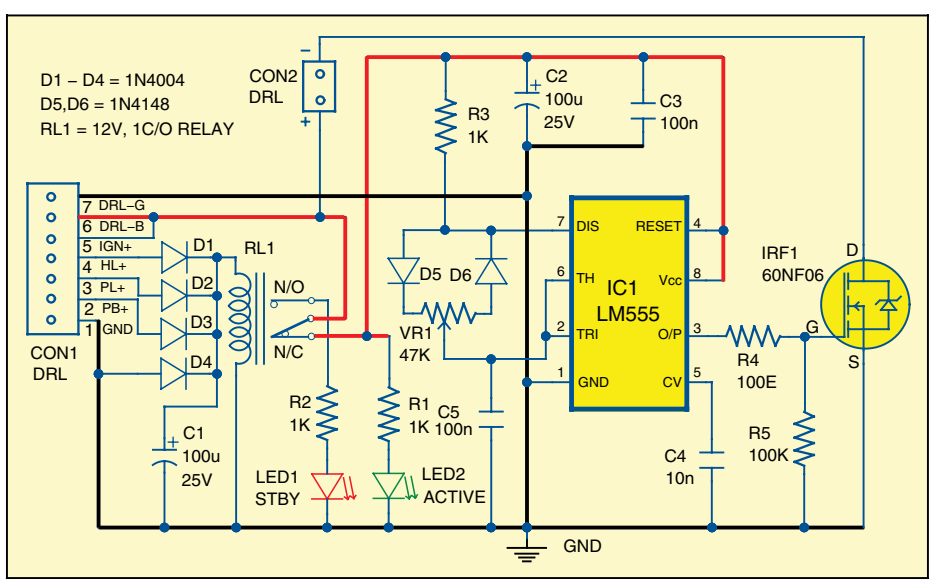


Fig. 2: Circuit diagram of the DRL controller

PARTS LIST

Semiconductors:

IC1	- LM555 timer
D1-D4	- 1N4004 rectifier diode
D5-D6	- 1N4148 signal diode
IRF1	- 60NF06 MOSFET
LED1, LED2	- 5mm LED

Resistors (all 1/4-watt, ±5% carbon):

R1-R3	- 1-kilo-ohm
R4	- 100-ohm
R5	- 100-kilo-ohm
VR1	- 47-kilo-ohm potmeter

Capacitors:

C1, C2	- 100µF, 25V electrolytic
C3, C5	- 100nF ceramic disk
C4	- 10nF ceramic disk

Miscellaneous:

RL1	- 12V, 1C/O relay
CON1	- 7-pin connector
CON2	- 2-pin connector
DRL	- Daylight running lights

Set Off mode as per your choice, or according to the relevant law of the land.

The default Set Off mode of the DRL is given below:

```
IGN+ (ignition): ON→DRL: ON
HL+/PL+/PB+ (headlight/park light/hand
brake): ON→DRL: OFF
```

The circuit is a simple pulse-width modulator (PWM) built around the ubiquitous 555 timer. User-controllable PWM output from IC1 is used to switch on the DRLs through MOSFET 60NF06 (as MOSFET on DRL ground is connected to circuit ground).

Here, 555 is configured as astable and, hence, it is possible to have completely-independent control of charge and discharge times of the timing capacitor by using two external diodes (D5 and D6). The 12V 1C/O electromagnetic relay in the circuit is used to enable/disable the DRL controller circuitry, as per status of the headlight/parking light/hand brake. LED1 indicates standby and LED2 indicates the active modes of the DRL controller.

Fig. 3: Photograph of the DRL

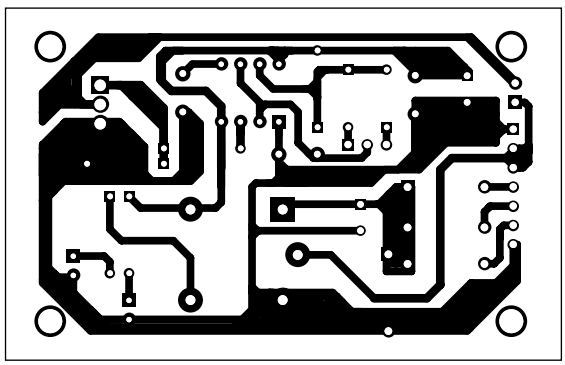


Fig. 4: Actual-size PCB of the DRL

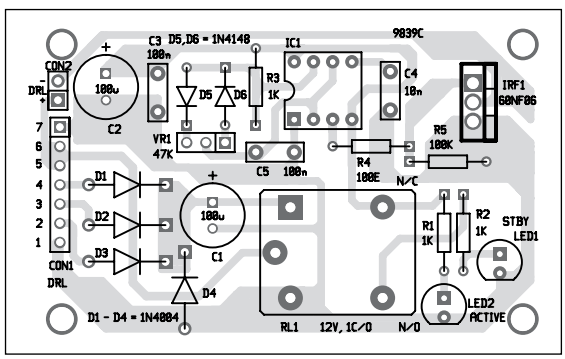


Fig. 5: Component layout of the PCB

Note. Driving the MOSFET from a noisy line calls for a small series gate resistor close to the MOSFET. Using a low-value 100-ohm resistor (R4) between the MOSFET driver and MOSFET gate terminal dampens down any ringing oscillations caused by lead inductance and gate capacitance, which can otherwise exceed the maximum voltage allowed on the gate terminal. Also, using pull-down 100k resistor (R5) from the gate to the source of the MOSFET is a good practice.

Construction and testing

An actual-size, single-side PCB for the DRL controller circuit is shown in Fig. 4 and its component layout in Fig. 5. Enclose the circuit in a suitable small box with connectors CON1 and CON2 on the front side to connect the seven control signals and the DRL.

After assembling the circuit, refer to the wiring guide table before connecting these to the PCB board.

Panel-mount the input and output interface, as required. ●

T.K. Hareendran is an electronics hobbyist, freelance technical writer and circuit designer

AC/DC Signal Mixer, Follower, Buffer and Inverter with 10 Inputs

PETRE TZV. PETROV

Often we want to add multiple AC/DC signals to produce the needed composite output signal. One such instance is when we want to add several audio signals for a home entertainment system, or when we wish to add several sinusoidal, triangular or rectangular signals. Another case is when we wish to add several arbitrary AC and DC voltages and produce a composite signal for testing purposes.

Here is a possible solution of a mixer and buffer working in the range of 0Hz to over 100kHz. The circuit can be used as part of audio equipment or as part of equipment for testing and measurement.

Circuit and working

Fig. 1 shows a simple AC/DC mixer with 10 inputs. It is built around dual op-amp NE5532 or RC4560 (IC1) and a few other components. Each input can be used for AC or AC + DC signals. Inputs on connector CON1 (DC1 through DC10) are for AC + DC signals. Inputs on connector CON2 (AC1 through AC10) are for AC only signals.

Any combination of inputs can be used but every input has usage as AC only or as AC + DC input. All inputs have the same parameters and the gain of all inputs is unity.

Input resistance of all inputs is 10-kilo-ohm and these can be driven by ordinary operational amplifiers (OAs) and most signal sources without any problem. Resistors R1 through R10 can be changed to any appropriate value.

PARTS LIST

Semiconductors:
IC1 - NE5532 or RC4560 op-amp
LED1 - 5mm LED

Resistors (all 1/4-watt, ±5% carbon):
R1-R15 - 10-kilo-ohm
R16 - 2.2-kilo-ohm
R17 - 100-ohm

Capacitors:
C1-C10 - 0.1µF ceramic disk
C11, C12 - 0.33µF ceramic disk
C13, C14 - 220µF, 35V electrolytic
C15 - 47µF, 35V electrolytic

Miscellaneous:
CON1, CON2 - 20-pin, 2-line female connector
CON3 - 3-pin connector
CON4-CON6 - 2-pin connector
- ±9V DC power supply

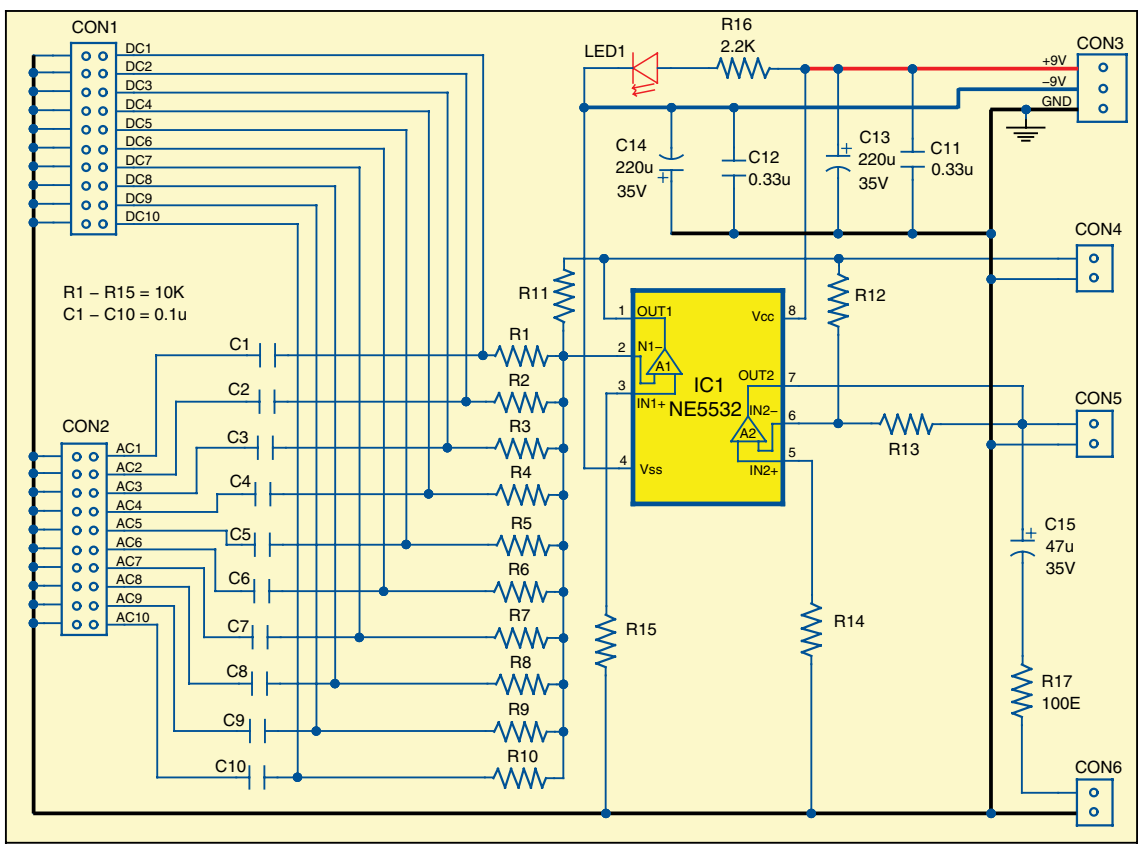


Fig. 1: Circuit diagram of the AC/DC signal mixer, follower, buffer and inverter with 10 inputs

Integrated circuit RC4560/NE5532 has two operational amplifiers. The first op-amp A1 of IC1 is used as a summing and inverting amplifier for all inputs. The resulting signal that is the inverted sum of all input signals with the same weight in the sum is presented on output connector CON4. This signal is inverted by the second op-amp A2 of IC1 and the result is available on connector CON5.

This way, the

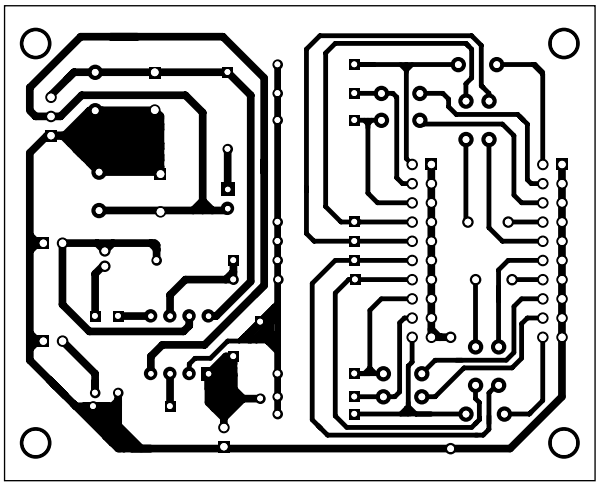


Fig. 2: Actual-size PCB of the mixer circuit

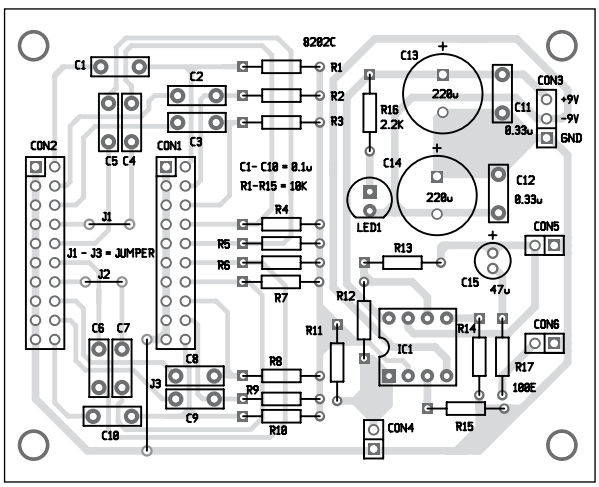


Fig. 3: Component layout of the PCB

circuit provides the inverted and the non-inverted sum of all input signals. Both outputs can be used simultaneously or individually. The outputs can drive loads as low as 400 ohms.

The DC component of the sum produced by second amplifier A2 is passed through DC-cutting capacitor C15 and is available on connector CON6.

The full power supply range of RC4560/NE5532 is available. This IC can work in the range of ±4V to ±18V (preferably up to ±15V). The quiescent current without signal is typically less than 10mA.

We have tested the circuit on ±9V power supply. The circuit can also be powered using dry batteries, two 6V or 12V rechargeable accumulators or well-regulated mains power supply.

IC RC4560 can work with loads as low as 400 ohms and can drive audio lines directly. With IC NE5532 the loads should be 600 ohms or more. The power supply of NE5532 can go up to ±20V and if the load is 2-kilo-ohm or more, the output voltage swing will be larger than with RC4560.

Usage of IC OPA2134 is also possible and will produce excellent results. If TL072 or TL082 are used in the circuit, output loads should be 2-kilo-ohm or more. This circuit of a simple AC and DC mixer, follower and buffer with ten inputs can work with signals of 0Hz to more than 100kHz, with a large variety of operational amplifiers.

The mixer does not contain any expensive or rare components and will work immediately after its assembly, if done properly.

Construction and testing

An actual-size, single-side PCB for the mixer circuit is shown in Fig. 2 and its component layout in Fig. 3. Enclose the PCB in a suitable small box such that connectors CON1 and CON2 can be used to connect ten inputs. Ensure proper wiring to avoid any mistake.

Panel-mount the input and output interface, as per requirement. ●

Petre Tzv. Petrov was a researcher and assistant professor in Technical University of Sofia, Bulgaria, and expert-lecturer at OFPPT (Casablanca), Kingdom of Morocco. He is currently working as an electronics engineer in the private sector in Bulgaria

Low-Frequency Electronic Muscle Stimulator

K. MURALI KRISHNA

Here is a simple low-frequency electronic muscle stimulator used in electrotherapy (use of electrical energy for medical treatment).

Electronic muscle stimulation or electronic stimulation makes use of a small voltage that aims at the motor nerves in a human body to excite these. It basically causes contraction of muscles. The muscles rest between shocks and contract again when the shocks occur. This regular contracting and relaxing has been used to cure various vascular and musculoskeletal conditions. This method makes the movement of oxygen and nutrients to the muscles much easier. General applications of electronic muscle stimulation are to stimulate sensory and motor nerves, facilitate muscle contraction, re-educate muscles, improve circulation and prevent/stretch adhesions.

Circuit and working

Fig. 1 shows block diagram of the muscle stimulator. The power-supply block has a transformer, 230V AC mains as input, bridge rectifier and filter.

The variable-voltage block provides variable voltage to the converter block. It is built around IC LM317 and produces voltages of 1.25V to 25V with a current of 1A. This block produces the required power for upping the voltage to the required level.

The fixed-voltage block provides a voltage of 5V to the astable multivibrator block.

The astable-multivibrator block is built around IC LM555 and produes low-frequency variable square wave. It provides frequency to the converter block, which produces the signal for the output block. Output from the converter is given to various points on the human body for stimulating the muscles.

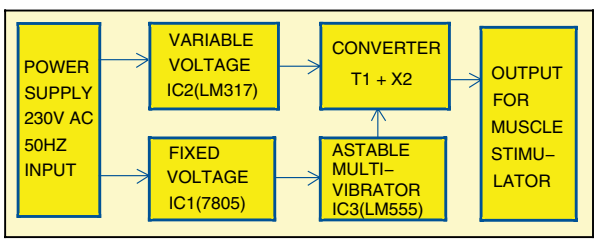


Fig. 1: Block diagram of the muscle stimulator

Fig. 2 shows circuit diagram of the stimulator circuit. It is built around transformer X1 and a bridge rectifier comprising diodes D1 through D4, filter capacitors C1 and C2, 5V voltage regulator 7805 (IC1), adjustable regulator LM317 (IC2), timer LM555 (IC3), transformer X2 and a few discrete components.

IC1 produces 5V fixed voltage to enable IC3, and IC2 produces adjustable voltage which is given to X2. LED1 indicates the presence of 5V DC.

The 555 timer is configured in astable-multivibrator mode. For stimulating muscles, low frequencies are used, ranging from 0.7Hz to 31Hz, which can be varied using potmeter VR1.

Output frequency at pin 3 of the 555 timer is used to drive transistor

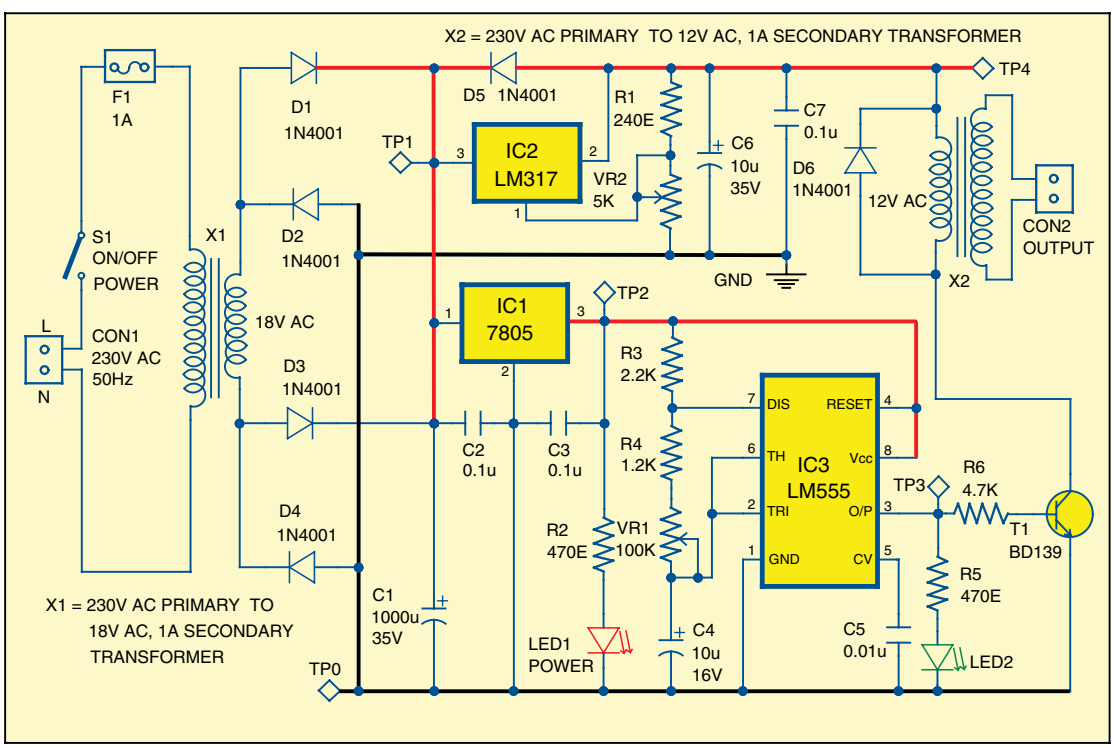


Fig. 2: Circuit diagram of the muscle stimulator

Test Points

Test point	Details
TP0	0V (GND)
TP1	Around 25V
TP2	+5V
TP3	Variable frequency
TP4	Around 1.2V to 25V

PARTS LIST

Semiconductors:
IC1 - 7805, 5V voltage regulator
IC2 - LM317 adjustable voltage regulator
IC3 - LM555 timer
D1-D6 - 1N4001 rectifier diode
T1 - BD139 npn transistor
LED1, LED2 - 5mm LED

Resistors (all 1/4-watt, ±5% carbon):
R1 - 240-ohm
R2, R5 - 470-ohm
R3 - 2.2-kilo-ohm
R4 - 1.2-kilo-ohm
R6 - 4.7-kilo-ohm
VR1 - 100-kilo-ohm potmeter
VR2 - 5-kilo-ohm potmeter

Capacitors:
C1 - 1000µF, 35V electrolytic
C2, C3, C7 - 0.1µF ceramic disk
C4 - 10µF, 16V electrolytic
C5 - 0.01µF ceramic disk
C6 - 10µF, 35V electrolytic

Miscellaneous:
CON1, CON2 - 2-pin connector terminal
F1 - 1A, fuse
S1 - On/off switch
X1 - 230V AC primary to 18V AC, 1A secondary transformer
X2 - 230V AC primary to 12V AC, 1A secondary transformer
- Probes

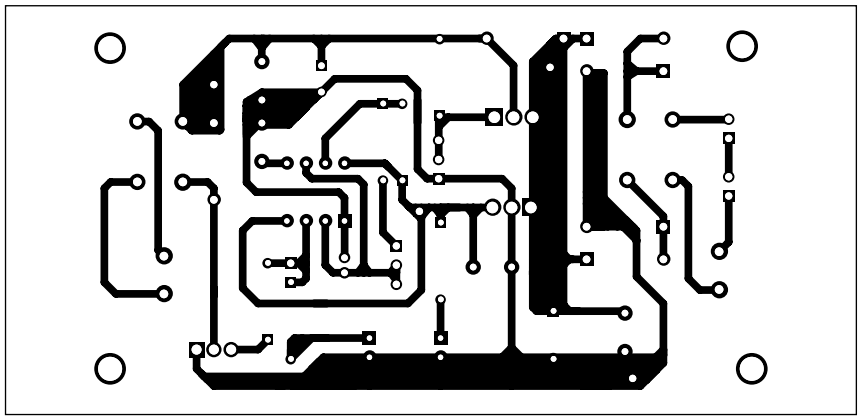


Fig. 3: Actual-size PCB of the muscle stimulator

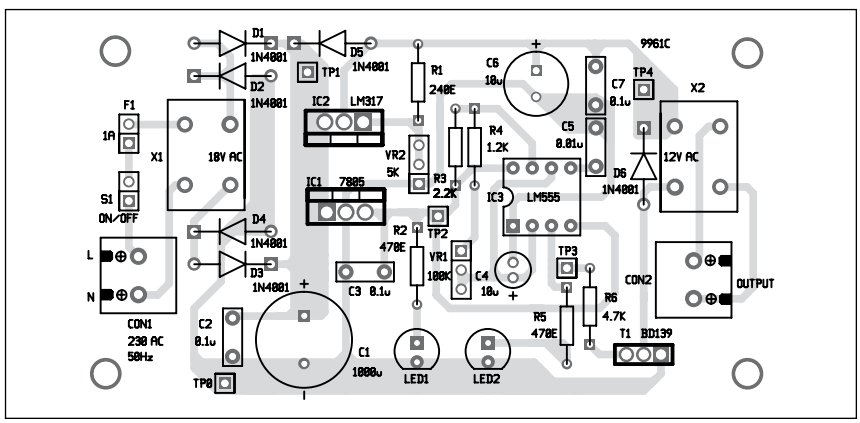


Fig. 4: Component layout of the PCB

T1. Output at pin 3 of the 555 timer is shown by LED2.

The next major section in the circuit generates variable DC voltage. This function is done by IC LM317 (IC2). It is an adjustable regulator capable of producing 1.25V to 25V. Potmeter VR2 is used to vary the voltage at pin 2 of IC2.

The converter is centred around transformer X2. Output of IC3 is a square-wave signal given to the base of transistor T1 via resistor R6. Output from IC2 is fed to the secondary of transformer X2. Transistor T1 acts as a switching transistor. The input voltage at secondary of X2 can be varied using VR2. When IC3 oscillates, the primary of X2 produces a voltage of around 70V to 90V.

Different muscles stimulate at different levels of voltage intensity, and stimulation also depends on the age of people. VR2 is labelled as intensity control. By varying VR2, different levels of intensities are obtained. VR1 is used to change the oscillation frequency of IC3.

Construction and testing

An actual-size, single-side PCB of the stimulator circuit is shown in Fig. 3 and its components layout in Fig. 4.

After assembling the circuit on the PCB, house it in a small cabinet. An old UPS cabinet can be used for housing the components and transformers. The cabinet can be fitted with fuse F1, on/off switch S1, indicator LEDs (LED1 and LED2) and variable resistors VR1 and VR2. Transistor T1 should be housed on small heat-sink. Panel mount the AC mains socket, on/off switch, fuse and output interface, as per requirement.

Verify that voltages at the test points are as shown in the test points table before using the circuit. Connector CON2 is used to measure the pulsed output voltage from X2 using an oscilloscope or a general-purpose multimeter. Set the intensity knob VR2 to minimum position and frequency knob VR1 to low. Place the probes at any two points on your body (not too far from each other). You should feel a tingling sensation which is produced by relaxation and contraction of the muscles.

Electrotherapy can also be used for improving the range of joint movement (example: frozen shoulder), treating neuromuscular dysfunction, improving strength, motor control and local blood flow, tissue repair and enhancing micro-circulation to heal wounds, under proper medical supervision. ●

K. Murali Krishna is a former senior assistant professor at Aditya Engineering College, Andhra Pradesh. Currently, he is working as telecom technical assistant at BSNL

Over-Heat Detector

PRADEEP G.

NTC thermistors are often the preferred choice for temperature sensing and control in many applications, primarily because of their small package sizes and attractive price-performance ratios. An NTC thermistor's sensitivity to temperature changes, even in small increments, enables the device to be used in temperature-sensing/control applications. This project for the over-heat detector uses a 10k NTC thermistor.

Circuit and working

The circuit diagram of the over-heat detector is shown in Fig. 1. It is built around a negative temperature co-efficient (NTC1), popular dual op-amp LM358 (IC1), 12V, 1C/O relay and a few other components.

The dual op-amp LM358 has been used here for sensing temperature variations near the sensor. At room temperature, thermistor resistance is around 10k. When the temperature increases, thermistor's resistance becomes low and output of IC1 at its pin 1 becomes high. As a result, the npn transistor conducts and activates the relay.

For testing the circuit, using potmeter VR1, set reference voltage, say, 2V, at pin 3 of IC1. At normal room temperature, voltage at pin 2 of IC1 remains around 2.4V.

On slightly heating NTC1, voltage at pin 2 of IC1 decreases. When this voltage goes below 2V, output of IC1 at pin 1 goes high and relay RL1 energises to activate the load connected to it.

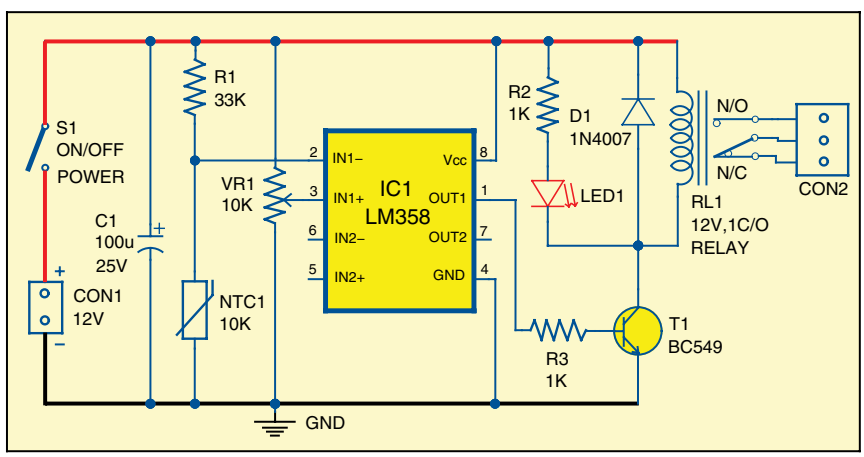


Fig. 1: Circuit of the over-heat detector

Construction and testing

An actual-size, single-side PCB for the over-heat detector is shown in Fig. 2 and its component layout in Fig. 3. Enclose the PCB in a suitable small box in such a way that the thermistor can be placed near the heating area. Since the thermistor is used as a sensor, better fix it at a spot from where it can sense the temperature. Ensure proper wiring of the circuit to avoid any mistake.

Panel-mount the input and output interface and the on/off switch, as required. ●

PARTS LIST

Semiconductors:
IC1 - LM358 dual op-amp
T1 - BC549 npn transistor
LED1 - 5mm LED
D1 - 1N4007 rectifier diode

Resistors (all 1/4-watt, ±5% carbon):
R1 - 33-kilo-ohm
R2, R3 - 1-kilo-ohm
VR1 - 10-kilo-ohm potmeter

Capacitor:
C1 - 100µF, 25V electrolytic

Miscellaneous:
CON1 - 2-pin connector terminal
CON2 - 3-pin connector
S1 - On/off switch
NTC1 - 10-kilo-ohm NTC thermistor
RL1 - 12V, 1C/O relay
- 12V DC power supply

Pradeep G. is B.Sc. (Physics) and a regular contributor to international magazines. He is also a small-business owner making school/college projects in South India

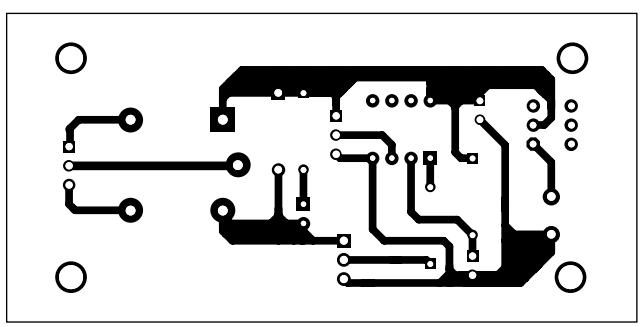


Fig. 2: Actual-size PCB of the over-heat detector

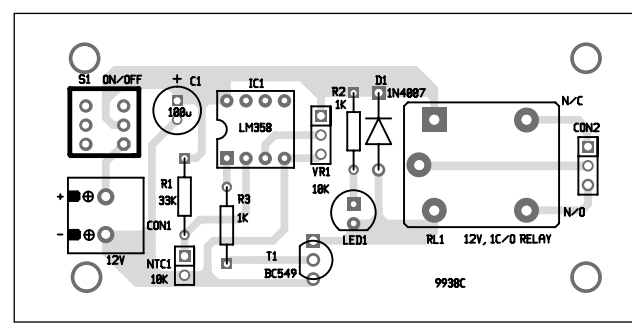


Fig. 3: Component layout of the PCB

Verilator

SHAKTHI KANNAN

Verilator is a Verilog hardware description language (HDL) simulator that can compile synthesisable Verilog code into C++ or SystemC. It is designed primarily for high-performance simulations, and supports simple assertions and code-coverage analysis. It is released under GNU LGPL/Perl artistic licence. You can install it on Fedora 20 (x86_64) using the following:

```
$ sudo yum install verilator
```

Consider a simple hello.v example.

```
module hello;

   initial begin
      $display("Hello!");
      $finish;
   end

endmodule
```

A C++ wrapper file is written to test drive the hello module.

```
#include "Vhello.h"
#include <verilated.h>

int
main (int argc, char **argv, char **env)
{
  Verilated::commandArgs(argc, argv);

  Vhello* top = new Vhello;

  while (!Verilated::gotFinish()) { top -> eval(); }

  exit (0);
}
```

You can compile the above code with Verilator and generate required simulation files with --cc.

```
$ verilator --cc hello.v --exe main.cpp
```

Before running main.cpp, you need to install GCC and GCC-C++ in your system.

This produces obj_dir with Makefiles and C++ code. These generated files can then be compiled using the following:

```
$ cd obj_dir
$ make -j -f Vhello.mk Vhello

g++  -I. -MMD -I/usr/share/verilator/include \
     -I/usr/share/verilator/include/vltstd -DVL_PRINTF=printf \
     -DVM_TRACE=0 -DVM_COVERAGE=0 \
     -c -o main.o ../main.cpp
g++  -I. -MMD -I/usr/share/verilator/include \
     -I/usr/share/verilator/include/vltstd -DVL_PRINTF=printf \
     -DVM_TRACE=0 -DVM_COVERAGE=0 \
     -c -o verilated.o /usr/share/verilator/include/
      verilated.cpp
/usr/bin/perl /usr/share/verilator/bin/verilator_includer \
     Vhello.cpp > Vhello__ALLcls.cpp
/usr/bin/perl /usr/share/verilator/bin/verilator_includer \
     Vhello__Syms.cpp > Vhello__ALLsup.cpp
g++  -I. -MMD -I/usr/share/verilator/include \
     -I/usr/share/verilator/include/vltstd -DVL_PRINTF=printf \
     -DVM_TRACE=0 -DVM_COVERAGE=0        \
     -c -o Vhello__ALLsup.o Vhello__ALLsup.cpp
g++  -I. -MMD -I/usr/share/verilator/include \
     -I/usr/share/verilator/include/vltstd -DVL_PRINTF=printf \
     -DVM_TRACE=0 -DVM_COVERAGE=0        \
     -c -o Vhello__ALLcls.o Vhello__ALLcls.cpp
      Archiving Vhello__ALL.a ...
ar r Vhello__ALL.a Vhello__ALLcls.o Vhello__ALLsup.o
ar: creating Vhello__ALL.a
ranlib Vhello__ALL.a
g++    main.o verilated.o Vhello__ALL.a    -o Vhello -lm
-lstdc++  2>&1 | c++filt
```

You can test the hello module with the following command:

```
$ cd ..
$ ./obj_dir/Vhello

Hello!
- hello.v:5: Verilog $finish
```

Verilator accepts a number of arguments as options. -V lists the version of the software and provides a summary of configuration and environment settings. A pre-processing output of the code is produced with -E, without actually compiling or generating any code. This is illustrated below.

```
$ verilator -cc hello.v -E

`line 1 "hello.v" 1
module hello;

`line 3 "hello.v" 0
   initial begin
      $display("Hello!");
      $finish;
   end

endmodule
`line 9 "hello.v" 2
```

-CFLAGS allows the user to override any C++ compiler flags during the build process. For example,

```
$ verilator -cc hello.v -CFLAGS -O0 --exe main.cpp
```

The respective flags are passed to the compiler in the

generated Makefiles. -O0 disables optimisation. The user can explicitly specify the level of optimisation with -On, where n is an integer. The highest level of optimisation is -O3.

Verilator can also produce SystemC output with -sc. SystemVerilog support also exists, and the relevant code can be generated with -sv.

If you want to analyse the intermediate steps in the compilation process, you can use --dump-tree:

```
$ verilator --dump-tree --cc hello.v --exe main.cpp

dot -Tps -o ~/a.ps obj_dir/Vhello_01_linkcells.dot
dot -Tps -o ~/a.ps obj_dir/Vhello_21_task_call.dot
dot -Tps -o ~/a.ps obj_dir/Vhello_33_gate_simp.dot
dot -Tps -o ~/a.ps obj_dir/Vhello_34_gate_opt.dot
dot -Tps -o ~/a.ps obj_dir/Vhello_40_orderg_pre.dot
dot -Tps -o ~/a.ps obj_dir/Vhello_41_orderg_acyc.dot
dot -Tps -o ~/a.ps obj_dir/Vhello_42_orderg_order.dot
dot -Tps -o ~/a.ps obj_dir/Vhello_43_orderg_domain.dot
dot -Tps -o ~/a.ps obj_dir/Vhello_44_ordermv_simpl.dot
dot -Tps -o ~/a.ps obj_dir/Vhello_45_orderg_done.dot
```

--cdc performs a clock domain crossing (CDC) analysis, which can be invoked on an input module as follows:

```
$ verilator -cc input.v --cdc
```

Verilator can check for warnings. Consider the following Verilog code:

```
module test;

   wire a, b, c;
   and (x, b, c);

endmodule
```

An implicit warning is produced by Verilator as shown below:

```
$ verilator -cc lint.v --exe main.cpp

%Warning-IMPLICIT: lint.v:4: Signal definition not found,
creating implicitly: x
%Warning-IMPLICIT: Use "/* verilator lint_off IMPLICIT
*/" and lint_on around source to disable this message.
%Error: Exiting due to 1 warning(s)
%Error: Command Failed verilator_bin -cc lint.v --exe main.cpp
```

Lint warnings can be disabled with -Wno-lint.

```
$ verilator -cc lint.v --exe main.cpp -Wno-lint
$
```

Verilator can also produce a useful statistics file with --stats. Vhello_stats.txt file is created in objdir for hello.v module.

```
$ verilator --cc hello.v --exe main.cpp --stats
```

There also exists --profile-cfuncs that adds profiling code to the generated C++ files. Tools like gprof [2] can be used on the generated output to analyse the input Verilog code.

```
$ verilator -cc hello.v --exe main.cpp --profile-cfuncs
```

The following is a half-adder example:

```
module ha(a, b, sum, carry);

   input a;
   input b;

   output sum;
   output carry;

   assign carry = a & b;
   assign sum = a ^ b;

endmodule
```

The simulation to test the half-adder example is given by main.cpp file.

```
#include "Vhalfadder.h"
#include <verilated.h>
#include "verilated_vcd_c.h"

unsigned int main_time = 0;

double sc_time_stamp () {
    return main_time;
}

int
main (int argc, char **argv, char **env)
{
  Verilated::commandArgs(argc, argv);

  Vhalfadder* top = new Vhalfadder;

  Verilated::traceEverOn(true);
  VerilatedVcdC* tfp = new VerilatedVcdC;

  top->trace (tfp, 99);
  tfp->open ("counter.vcd");

  top -> sum   = 0;
  top -> carry = 0;

  top -> a = 0;
  top -> b = 0;

  while (main_time < 5 && !Verilated::gotFinish()) {

    if ((main_time % 4) == 0) {
      top -> a = 0;
      top -> b = 0;
    }

    if ((main_time % 4) == 1) {
      top -> a = 1;
      top -> b = 0;
    }
```

```
    if ((main_time % 4) == 2) {
      top -> a = 0;
      top -> b = 1;
    }

    if ((main_time % 4) == 3) {
      top -> a = 1;
      top -> b = 1;
    }

    top -> eval();

    if (tfp) tfp -> dump(main_time);

    main_time ++;
  }

  top -> final();

  if (tfp) tfp -> close();

  delete top;

  exit(0);
}
```

The while loop handles the different cases for various combinations of the input. Steps to compile, build and test the half-adder example can be automated in a Makefile.

```
TARGET=halfadder

all:
    verilator -cc $(TARGET).v --exe sim_main.cpp --trace

build:
    make -j -C obj_dir -f V$(TARGET).mk V$(TARGET)

test:
    ./obj_dir/V$(TARGET)

clean:
    rm -rf obj_dir *~ *.vcd
```

Sources can be compiled with Verilator using make.

```
$ make

verilator -cc halfadder.v --exe_main.cpp --trace
```

The generated C++ code is then built using the following:

```
$ make build

make -j -C obj_dir -f Vhalfadder.mk Vhalfadder
make[1]: Entering directory `/home/guest/halfadder/obj_dir'
g++  -I. -MMD -I/usr/share/verilator/include \
     -I/usr/share/verilator/include/vltstd -DVL_PRINTF=printf \
     -DVM_TRACE=1 -DVM_COVERAGE=0 \
     -c -o main.o ../main.cpp
```

Fig. 1: Waveform

```
g++  -I. -MMD -I/usr/share/verilator/include \
     -I/usr/share/verilator/include/vltstd -DVL_PRINTF=printf \
     -DVM_TRACE=1 -DVM_COVERAGE=0 \
     -c -o verilated.o /usr/share/verilator/include/
      verilated.cpp
g++  -I. -MMD -I/usr/share/verilator/include \
     -I/usr/share/verilator/include/vltstd -DVL_PRINTF=printf \
     -DVM_TRACE=1 -DVM_COVERAGE=0 -c -o verilated_vcd_c.o \
     /usr/share/verilator/include/verilated_vcd_c.cpp
/usr/bin/perl /usr/share/verilator/bin/verilator_includer \
     Vhalfadder.cpp > Vhalfadder__ALLcls.cpp
/usr/bin/perl /usr/share/verilator/bin/verilator_includer \
     Vhalfadder__Trace.cpp Vhalfadder__Syms.cpp \
     Vhalfadder__Trace__Slow.cpp > Vhalfadder__ALLsup.cpp
g++  -I. -MMD -I/usr/share/verilator/include \
     -I/usr/share/verilator/include/vltstd -DVL_PRINTF=printf \
     -DVM_TRACE=1 -DVM_COVERAGE=0        \
     -c -o Vhalfadder__ALLcls.o Vhalfadder__ALLcls.cpp
g++  -I. -MMD -I/usr/share/verilator/include \
     -I/usr/share/verilator/include/vltstd -DVL_PRINTF=printf \
     -DVM_TRACE=1 -DVM_COVERAGE=0 \
     -c -o Vhalfadder__ALLsup.o Vhalfadder__ALLsup.cpp
      Archiving Vhalfadder__ALL.a ...
ar r Vhalfadder__ALL.a Vhalfadder__ALLcls.o Vhalfadder__
ALLsup.o
ar: creating Vhalfadder__ALL.a
ranlib Vhalfadder__ALL.a
g++    main.o verilated.o verilated_vcd_c.o Vhalfadder__ALL.a  \
     -o Vhalfadder -lm -lstdc++  2>&1 | c++filt
make[1]: Leaving directory `/home/guest/halfadder/obj_dir'
```

You can test the code with the following:

```
$ make test

./obj_dir/Vhalfadder
```

This produces counter.vcd file, which can be viewed in GTKWave. A screenshot of the waveform is shown in Fig. 1.

EFY Note

The source codes of this project are included in this month's EFY DVD and are also available for free download at *source.efymag.com*

Install GTKwave before viewing the waveform.

You may also refer to Verilator manual at *www.veripool.org/projects/verilator/wiki/Manual-verilator* for more options and examples. ●

Shakthi Kannan is MS in information technology from Rochester Institute of Technology, Rochester, New York, the USA. Currently, he is working as senior engineer (R&D) at Manufacturing System Insights, Chennai. He is a software enthusiast who blogs at shakthimaan.com

Wireless Portable Speaker from Harman Kardon

Accessorise your sound wherever you go

The Harman Kardon Esquire, a portable speaker, is Bluetooth-enabled with a built-in conference phone system that changes the way you travel with your music. It is durable and features a leather panel and metal finish on the outside. On the inside, it features dual drivers and a built-in bass port for clear sound, as well as custom-tuned microphones and noise-cancellation technology for clear conference calls from your Bluetooth-enabled smartphone.

Its 3-port USB adapter allows you to charge multiple devices at the same time. Whether conferencing with one person or with a group, this dual-microphone system delivers quality sound and reliable connections wherever you are, and with smart orientation, you can aim the speaker in any direction and not miss a single word.

It features 80dB signal-to-noise ratio (SNR), 80kHz to 22kHz frequency response, 2Wx10W amplifier power (peak), 0 ~ 4dBm Bluetooth transmitter power and 7.4V/4000mA li-ion battery. It is available in three colour variants, namely, black, brown and white.

Price: ₹ 19,990

SUHD 4K curved smart TV from Samsung

Featuring ultra-high-definition pictures that take you to the visual beyond

Samsung's curved smart television takes you to a world of immersive viewing and makes you feel as though you are right in the middle of the excitement. The UHD screen is curved at an angle that provides the best viewing distance for the living room and gives you uniform and balanced viewing from all areas of the screen. It features a smart television menu bar that gives faster, smoother and truly intuitive access to all the available content.

Price: ₹ 440,900 for the 165.1cm (65-inch) variant

The SUHD TV's nano-crystal technology features nano colour (64 times more colour expression), nano brightness (2.5 times brighter) and nano contrast (10 times higher contrast), when compared to Samsung's 4K smart TV.

It enables seamless convergence between a mobile device and the television, along with allowing surfing online content while viewing television. You can do this with just one click.

It is available in two sizes, namely, 165.1cm (65-inch) and 139.7cm (55-inch).

Teewe launches HDMI dongle

Stream media to the TV wirelessly with the tap of a finger

This new and improved media-streaming stick, Teewe 2, lets you play anything on your television at any time from the comfort of your couch. With Teewe, you can stream local and online media wirelessly via a smartphone application to your television. The Teewe Desktop app lets you watch downloaded movies, television shows and other media files on television. It even organises these with tags and meta-data.

The device works as a complete central processing unit (CPU) with a dual-core ARM Cortex A9 processor with a quad-core GPU for high performance, 1.6 + GHz and 1GB of DDR 3 RAM. It works with any television with an HDMI port and needs a Wi-Fi 802.11 b/g/n connection to stream.

Price: ₹ 2399

GizMo ByTes

AdBlock Plus launches mobile browser

After facing problems with its existing mobile software, AdBlock Plus for Android, with respect to visibility and privacy, the company decided to build its own mobile browser. This browser aims to block advertisements automatically, which can save battery power, keep users safe from threats and give users control of their browsing on-the-go. The browser is currently in open-beta stage and can be tested by joining Adblock Browser Beta Google+ community.

Intex and Singapore firm to launch free calling app

A Singapore based mobile application company has entered into partnership with Indian smartphone maker Intex Technologies for creating a free calling app called nanu for the Indian market. The app subsidises cost through targeted advertising on ringtones of dialers and is designed to operate in 2G areas, opening up to the market of rural India. It provides all calls for free, including calls to non-nanu users on landlines and mobiles across the world.

Instamojo launches method of transferring money

Instamojo, a payments company, has unveiled a method of transferring money without having to remember bank account details. To use this feature, Instapay, a business or individual would have to share his or her Instamojo username to the payer, who can then transfer money to the account using various methods of payment such as debit or credit cards or net banking. The money will be transferred electronically to the user's bank account.

Sennheiser URBANITE launched in India

For those who refuse to settle for anything less than the best

These on-ear headphones aim to deliver the most intense sound pleasure—with massive bass that maintains excellent clarity even in low frequencies. The headphones are robust and extra rugged for everyday use. Their foldable design allows the sides to collapse and rest in their own storage pouch after use. These come with a detachable cable that features a 3-button remote control and an integrated microphone for taking calls and controlling music on smartphones and tablets.

Some key features include 18-ohm impedance, 118dB at 1kHz and 1Vrms sound-pressure level (SPL), omni-directional microphone pick-up pattern and supra-aural ear coupling, among others. It weighs only 260gm and comes in many stylish colours such as denim, sand, plum, nation and black.

Price: ₹ 15,990

Videocon launches VA81M tablet

For a pocket-friendly Android experience

The Videocon VA81M tablet comes packaged with a hardware capacity that includes 1.3GHz dual-core processor, 512MB RAM and 4GB internal storage (ROM), which is expandable up to 32GB. It runs on Android KitKat 4.4 operating system and offers amazing graphics experience with its 17.8cm (7-inch) WSVGA screen, enabling bright colours and wide viewing angles for videos, online content and games. The device packs in a 3000mAh battery and 3G network connectivity.

The tablet comes with various inbuilt networking and utilities features like Wi-Fi, dual-SIM support, voice calling, video calling, GPS/A-GPS navigation and Bluetooth. It features 2MP rear camera and VGA front camera.

Price: ₹ 4900

Five Tablets Under ₹ 25,000

WWW.EFYTIMES.COM

We all thought that tablets will replace netbooks and notebook PCs, but that did not happen. Tablet PCs are great for browsing the Web, reading books, watching movies and doing some light processing work.

These days you can buy a great tablet PC under ₹ 20,000. The major concerns while buying one are the tablet's battery life and productivity. Listed in this article are five budget tablet PCs available in the Indian market today.

Price: ₹ 12,999

1. Xiaomi Mi Pad

- NVIDIA Tegra K1 quad-core 2.2GHz ARM Cortex-A15 processor
- 20.1cm (7.9-inch) IPS high-resolution display
- 2048x1536 resolution at 326 pixels per inch (PPI), Gorilla glass 3
- 2GB LPDDR3 RAM, 16GB flash (128GB expandable)
- 8MP BSI camera f/2.0, 5MP front camera
- 6700mAh lithium-ion-polymer battery
- Dual-band 802.11ac Wi-Fi, 2x2 MIMO antenna

Price: ₹ 13,900

2. Samsung Galaxy Tab 4

- Android KitKat v4.4
- 17.7cm (7-inch) 1200 x 800 WXGA display with 215 PPI
- 1.2GHz quad-core processor
- WXGA display
- 1.5GB RAM
- 1.3MP front camera, 3MP rear camera
- 4000mAh battery

Price: ₹ 17,900 for the 16GB variant

3. Apple iPad Mini

- 20.1cm (7.9-inch) LED-backlit multi-touch display with IPS technology
- 1024x768 resolution at 163 PPI
- Fingerprint-resistant oleophobic coating
- A5 chip
- Bluetooth 4.0 technology
- Sensors: 3-axis gyro, accelero-meter and ambient light sensor
- 5MP iSight camera, 1.2MP FaceTime HD front camera

4. ASUS MeMO Pad 8

Price: ₹ 19,999

- Android 4.4
- Intel Atom Z3560 quad-core, 1.8GHz processor
- 20.3cm (8-inch) full-HD (1920x1200) IPS display with Corning Gorilla glass 3
- Pen function supported (tip size > 1.5mm)
- 1.2MP front camera, 5MP rear camera
- Anti-fingerprint coating
- 16GB eMMC
- LTE- and 3G-embedded

5. Lenovo MIIX 3 (10.1)

Price: ₹ 22,039

- Windows 8.1 with Bing
- 25.6cm (10.1-inch) wide-view display
- Intel Atom processor
- Up to FHD (1920x1200) IPS display
- 2GB DDR3L memory
- Up to 32GB eMMC storage
- Five-finger multi-touch technology

The prices mentioned here are from various e-commerce portals and are subject to change.

Why Buy Bluetooth Speakers

Sushma Rani is a content-developer-cum-sub-editor at EFY

Nothing can brighten up a dull moment like a favourite melody. Music plays an important part in our lives. It brings positive energy to our hectic, stressful lives. And, with growing levels of stress today, everyone can make use of a good Bluetooth speaker.

Bluetooth speakers or wireless speakers are basically loudspeakers that receive audio signals using radio frequency (RF) waves rather than over audio cables. These speakers are compatible with nearly all smartphones and tablets and are available in many different shapes and sizes. Users can choose from a variety of different brands that offer wireless speakers in their product lineup.

With a portable Bluetooth speaker, you can take your music wherever your celebration takes you and enjoy quality music with convenience.

Different speakers are designed for different needs. While it is great to have a wide range of available choices, it also means that it becomes more difficult to figure out which portable Bluetooth speaker would be right for you. In this article, we have listed out some key features that could help you in finding the right Bluetooth speaker based on your preference and needs.

Sound quality

The quality of sound should always come first. If the audio does not sound good, there is hardly any point in listening to it.

Bluetooth speakers can be rated on the basis of their ability to reproduce all audible frequency ranges accurately using a wide variety of genres. You must look for bass and the mid-range that needs to be balanced and detailed, and the high-range treble that needs to be crisp. Today, the latest Bluetooth speakers offer powerful sound quality. Some of the speakers bundle surround sound with twin speakers.

Size

While going for a Bluetooth speaker, it is important to look at its portability. Larger speakers will give bigger sound and greater volume, but if you are planning to carry your speaker with you all the time, you must go for a smaller one. Today, the market for smartdevices is growing rapidly and a lot of options with regards to the size of the speakers are available. Tech companies are coming up with smaller devices every day that provide quality sound.

SOME BLUETOOTH SPEAKERS AVAILABLE IN INDIA

	Zebronics–Zeb 655IIM	Amkette Trubeats Metal	Creative D100	Jabra Solemate Mini	Logitech UE Mobile Boombox	JBL Flip
						
Price	₹ 599	₹ 2149	₹ 3649	₹ 3999	₹ 4295	₹ 4399
Features worth looking at	• Micro 5-pin USB plug charging port • Bluetooth version: V3.0+EDR class 2; Bluetooth profile: HSP, HFP, A2DP • RF frequency range: 2.4G ISM band • Speaker output power: 10mW • Talk time: Up to five hours • Playback time: Up to 4.5 hours • Rechargeable high-capacity lithium-polymer battery	• Metal cylinder fits 40mm speaker • Built with cylindrical metal alloy drum • Call-answering and track-changing capability • 3.5mm auxiliary input • Call answering capability with the inbuilt microphone • Mini-USB charging port for charging the built-in battery	• Capable of using four AAA size batteries • Two-channel speaker with Bluetooth 2.1 + EDR wireless chip • 5V AC power inlet • 3.5mm jack for auxiliary input and a power on/off button • Weighs a little less than one kg	• Powerful sound • NFC support • Rubbery exterior • 3.5mm auxiliary input port • Micro-USB charging • 3.5mm audio cable	• Two devices can be paired at the same time • Lightweight • Power switch, battery indicator light, charging port • 3.5mm audio-in jack • Call-answering capability	• Could be used horizontally or vertically • Call-answering capability • Cylindrical shape • Auxiliary input • Includes a rechargeable battery for playback up to five hours • 10W of peak output

The prices mentioned here are from various e-commerce portals and are subject to change.

Battery life

Battery plays an important role when choosing a smartdevice. Some Bluetooth speakers function as battery banks for mobile devices. Some speakers have a USB port, which allows the speaker's battery to be used as an external battery for a smartphone. This option could become a saviour for your smartphone battery.

The Bluetooth speaker should also have a battery-life indicator so that you know how much life remains, as the battery life of a Bluetooth speaker can range drastically, from six hours to 40 hours. However, most Bluetooth speakers rely on a rechargeable battery so that you do not have to leave it tethered to an outlet when streaming music.

Features to look for

With companies introducing Bluetooth speakers in the market regularly, new and advanced features can be found on these speakers. Innovative speakers are water-resistant and can be used anywhere, from a fence to a shower caddy. For regular days, the speakers can be used as a perfect outdoor accessory.

Some systems have outputs for adding additional sub-woofers or for sending videos from a docked machine like an Apple iPad, iPhone or iPod to a TV. Other models may offer an optical digital audio input for connecting other gear such as a home CD player to the wireless system.

Portable and lightweight speakers are easy to carry around. These deliver crystal-clear sound and can be easily paired with any Bluetooth device.

Most speakers come powered with a rechargeable lithium battery, which helps these to keep running for longer hours, and support a microSD slot. Some speakers also feature radio.

Some even come with remote controls or voice recognition in order to simplify use, but these can be a hit or miss.

Control. Many Bluetooth profiles allow the speakers to communicate with various control features. In some devices, Headset profile allows you to use the speakers as a speakerphone, Hands-Free profile allows you to use voice commands and Audio/Video Remote Control profile allows you to control your playlist from the speakers itself, without which you can only pause or skip songs from your smartphone or tablet.

Water-resistant. Some of the latest speakers are water- and sand-resistant, allowing you to use these around the pool or at the beach. Many Bluetooth speakers have mounts and straps that allow you to take these hiking, biking or rafting, too.

Whether you are at a party at the beach, high on the mountain or in your backyard, there is no reason why you cannot have all your favourite tunes filling the air.

Easy setup. With options like near-field communication (NFC) technology, setting up Bluetooth speakers have become quite easy. NFC enables pairing by tapping an NFC-equipped device to the NFC tag on the speaker. Also, some Wi-Fi models can be among the easiest to use, overall.

Speakerphone. A few Bluetooth speakers provide built-in microphones that allow you to use the speakers as Bluetooth speakerphones. So, if you like to spend time with your phones, this could be a favourable option for you. There are many Bluetooth speakers you could take on your day trips to the beach or use at home. A little time spent making sure the portable boom box you are about to purchase has all the features you want and need can make all the difference. In return, you will get something you would constantly enjoy at home and while on the road.

Style. It is worth mentioning that several models available in the market come in stylish designs and shapes. While some models are plain and boxy, some have striking designs. So, once you have covered the technical aspects, it makes sense to go for one that is easy on the eyes.

Finally, once you go wireless (Bluetooth), you would not like to return to the world of wires. And, the best way to get rid of the messy wires is to grab a portable Bluetooth speaker. ●

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February	3D Printing	Coil Wound Components	Handheld T&M Equipment for Field Engineers
March	Wearables (Smart Humans)	SMT Manufacturing Equipment	Digital Multimeters
April	3G, 4G & Beyond: Latest in Telecom	Industrial Inverters & UPSes for Corporate	FPGA Based Development Boards
May	Virtual Electronics (on Web)	Telecom & Electronics	3D Printers (Under ₹ 100,000)
June	Printed and Flexible Electronics	Educational & Training Products	Wi-Fi & RF Modules
July	Smartcars	Automotive Electronics	Budget-Friendly Oscilloscopes
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September	Medical Electronics	Aerospace & Defence Electronics	Soldering/Desoldering Stations
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